ENERGY REPORT

ENERGY ENGINEERING ANALYSIS PROGRAM

LIMITED ENERGY STUDY

FORT HUNTER-LIGGETT, CALIFORNIA 1993

VOLUME I

PREPARED FOR

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

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DEPARTMENT OF THE ARMY
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1.0 Executive Summary

1.1 Introduction

This report summarizes all work or the Limited Energy Study, Energy Engineering Analysis Program (EEAP), fort Hunter Liggett, California, authorized under Contract Number DACA 05-92-C-0155 with the U.S. Army Corps of Engineers, Sacramento District, California.

The purpose of this study is to develop projects and actions that will reduce facilities energy consumption and operating costs at Fort Hunter Liggett. Implementation of these projects will contribute to achieving the goal of the Army Facilities Energy Plan of a reduction in energy consumption per square foot of building floor area of 20 percent by FY2000 from FY1985 baseline levels.

1.2 Installation Profile

There are 205 numbered structures at Fort Hunter Liggett, containing a total of 791,034 square feet of gross floor space. This Limited Energy Study evaluates 52 surveyed buildings with results extended to an additional 44 identical or similar buildings. Together, these buildings contain a total of 632,386 gross square feet and account for approximately 93 percent of overall energy usage.

1.3 Present Energy Consumption

Total energy consumption at Fort Hunter Liggett in FY1992 of non-transportation energy sources was 79,728 million Btu. This figure includes electricity at 3,413 Btu per kWh, No. 2 fuel oil at 138,700 Btu per gallon and propane at 95,000 Btu per gallon.

A breakdown in FY1992 energy consumption and cost for all three sources is as follows:

Energy Source	Quantity	Million Btu's	Cost
Electricity	11,605,000 kWh	39,608	$1,034,746
No. 2 Fuel Oil	136,058 gallons	18,871	$97,845
Propane	223,700 gallons	21,249	$174,724

1.4 Energy Conservation Analysis

A summary of all potential energy conservation opportunities (ECOs) investigated is presented in Table 1-1. This table includes a matrix of reasons for eliminating ECOs from further consideration. A summary of analysis results of recommended ECOs is

presented in Table 1-2, and a summary of analysis results of ECOs rejected is presented in Table 1-3.

1.4.1 ECIP Projects Developed

An ECIP project covering cantonment facility energy improvements was developed that includes the following retrofit measures:

a. Install batt insulation in the ceilings of 9 buildings.

b. Install programmable controllers in 9 buildings.

c. Insulate hot water heating and cooling water piping in 12 buildings.

d. Install 24-hour programmable thermostats in 28 buildings.

e. Replace spare cooling equipment in 10 buildings with more efficient systems.

f. Install automatic-draft damper controls on space heating equipment in 20 buildings.

g. Convert dual-duct air handling system to variable air volume in 5 barracks buildings.

h. Replace boilers with high-efficiency units in 7 buildings.

i. Insulate domestic hot water piping in 6 buildings.

j. Insulate 16 domestic hot water storage tanks in 13 buildings.

k. Install self-metering lavatory faucets in 3 buildings and install lavatory and shower flow restrictors in 2 buildings.

l. Install dishwasher heat recovery unit in Building 206.

m. Install automatic-draft dampers on domestic hot water heaters in 3 buildings.

n. Replace incandescent lighting fixtures with fluorescent fixtures in 9 buildings.

o. Install automatic power factor correction equipment at utility metering point. Install power factor correction capacitors on 10 HP and larger motors in 6 buildings.

The following ECIP project data is from the life cycle cost analysis summary sheet:

Construction Cost (Including SIOH)	$833,000
Annual Energy Savings	
Electricity	2,188 million Btu
No. 2 Fuel Oil	3,277 million Btu
Propane	4,242 million Btu
Annual Dollar Savings (Annualized)	$142,191
Savings-to-Investment Ratio (SIR)	2.25
Simple Payback Period	5.9 years
Analysis Date	June 1993

9,707 x10⁶ Btu

1.4.2 Non-ECIP Projects Developed

It is recommended that Fort Hunter Liggett Directorate of Engineering and Housing program personnel to adjust the temperature setpoints on domestic hot water heating systems annually. A summary of the life cycle cost analysis supporting this recommendation follows:

Construction Cost (First Year Operations)	$5,585
Annual Energy Savings	
Electricity	199 million Btu
No. 2 Fuel Oil	578 million Btu
Propane	430 million Btu
Annual Dollar Savings	$4,891
Savings-to-Investment Ratio (SIR)	13.33
Simple Payback Period	1.1 years
Analysis Date	June 1993

1.5 Energy and Cost Savings

If all recommended ECOs are implemented, total energy savings of 11,500 million Btu and total annual cost savings of $167,000 will result.

As shown in the pie chart in Figure 1-1, the potential savings represents 17.2 percent of the existing base-wide energy consumption.

PROJECTED ENERGY CONSUMPTION BY END USE

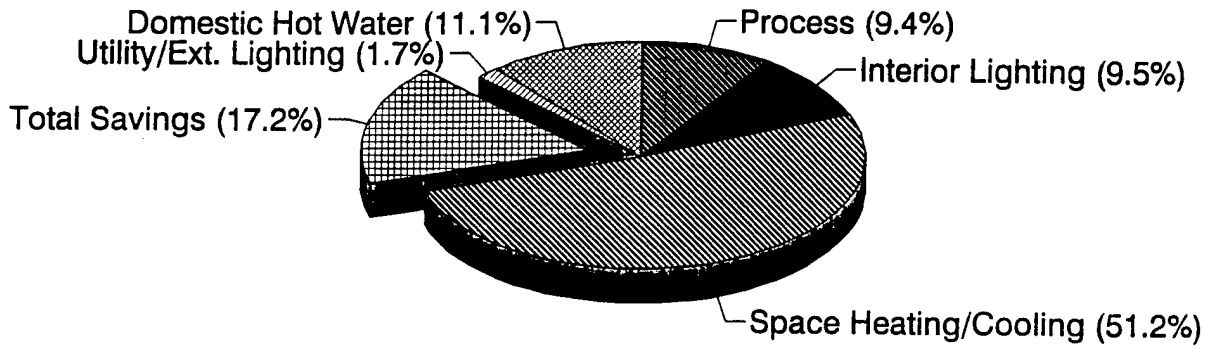

FIGURE 1-1

TABLE 1-1
Summary of ECO Evaluations
Fort Hunter Liggett, California

No.	Description of ECO	Recommended Project	SIR Less Than 1.0	DEH Maintenance	PG&E Project	N/A
	Architectural					
A1	Caulk and Weatherstrip		✓			
A2	Install Double Glazing					✓
A3	Insulate Exterior Walls		✓			
A4	Insulate Ceilings and/or Roofs	✓				
A5	Install Solar Film		✓			
A6	Reduce Glass Area					✓
A7	Install Shading Devises		✓			
	HVAC					
B1	Install Duty Cycling Controls	✓				
B2	Shade Condensers from Direct Sunlight		✓			
B3	Insulate Ductwork		✓			
B4	Replace Heating System Pipe Insulation	✓				
B5	Install Outside Air Temperature Reset		✓			
B6 B7	Install Time Clocks and Programmable Thermostats	✓				
B8	Replace Inefficient Chillers	✓				
B9	Install Heat Recovery System		✓			
B10	Install Automatic Flue Dampers on Heating System Boilers	✓				
B11	Install Economizer Cycle		✓			
B12	Install Boiler Oxygen Trim Controls and Revise Controls		✓			
B13	Install Evaporative Precoolers		✓		✓	
B14	Install Multizone Controls		✓		✓	
B15	Convert Multizone HVAC System to Variable Air Volume	✓			✓	
B16	Automate Summer/Winter Switchover	Evaluated as part of ECO B6/B7			✓	
B17	Relocate Transformer	✓		Done May 93	✓	
B18	Add Zone Optimizer to Reheat Systems		✓		✓	
B19	Add Deadband Controls	Evaluated as part of ECO B6/B7			✓	
B20	Consolidate Food Storage				✓	✓

TABLE 1-1
Summary of ECO Evaluations
Fort Hunter Liggett, California

No.	Description of ECO	Recommended Project	SIR Less Than 1.0	DEH Maintenance	PG&E Project	N/A
B21	Replace Inefficient Boilers with Higher-Efficiency Boilers	✓				
	Domestic Hot Water (DHW)					
C1	Reduce Hot Water Temperatures	✓				
C2	Replace Pipe Insulation DWH Systems	✓				
C3	Insulate Hot Water Storage Tanks	✓				
C4	Install Electrical Ignitors in Gas Hot Water Heaters					✓
C5	Install Aerators/Flow Restrictors in Lavatories and Showers	✓				
C6	Use Cold Water for Laundering					✓
C7	Replace Electric Booster for Garbage Can Washer	✓		Disconnected by DEH	✓	
C8	Recover Heat from Dining Facility Dishwashing	✓				
C9	Install Automatic Draft Damper Controls on DHW Heaters	✓				
	Lighting and Electrical					
D1	Reduce Lighting Levels					✓
D2	Install Time Clocks on Exterior Lighting				✓	✓
D3	Retrofit Exterior Lighting with HPS Fixtures		✓		✓	
D4	Replace Incandescent Lighting with Fluorescent	✓			✓	
D5	Install Electronic Ballasts and T8 Lamps		✓			
D6	Revise Transformer Loading					✓
D7	Improve Voltage Regulation					✓
D8	Improve Power Factor	✓				
D9	Replace Motors with High Efficiency Units		✓	✓		
D10	Install FM Radio EMCS		✓			

Table 1-2
Summary of Analysis Results for Recommended ECO's

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	Cost Savings LCC $	Investment $	SIR
C7	Replace Electric Booster for Garbage Can Washer (Implemented by DEH)	(144.0)		102.0	(42)	$7,865	$90,526	$536	168.79
C1	Reduce Hot Water Temperatures (DEH O&M project)	430.0	578.0	199.2	1,207	$4,891	$74,457	$5,585	13.33
B6/B7	Install Time Clocks & Night Set Back/Setup	2,460	3,399	1,252	7,111	$53,286	$715,760	$66,368	10.79
B1	Install Load Shedding System (Local Controllers)			130.8 kW	130.8 kW	$14,122	$165,227	$26,187	6.03
C5	Install Aerators/Flow Restrictors in Lavatories and Showers		2.0	13.0	15	$250	$2,964	$501	5.91
C2	Replace Insulation on DHW Pipes and Fittings	48.0	15.0		63	$357	$4,968	$856	5.81
C9	Install Automatic Draft Damper Controls	51.0	31.0		82	$498	$6,954	$1,909	3.64
C8	Recover Heat From Dishwasher Hot Water	339.0			339	$1,528	$21,483	$6,510	3.30
B17	Relocate Transformer (Implemented by DEH)			21.5	22	$588	$8,540	$2,676	3.19
B10	Automatic Draft Damper Control on Space Heating Equipment	282.2	174.3		457	$2,777	$38,790	$14,561	2.66
A4	Insulate Ceilings/Roofs	88.0	289.0	69.0	446	$4,220	$71,904	$28,430	2.53
B4	Replace Insulation on Heating Piping and Fittings (See Note 1)	60.6	39.1	0.1	100	$540	$7,750	$3,115	2.49

Table 1-2 (Cont.)
Summary of Analysis Results for Recommended ECO's

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	LCC $	Investment $	SIR
D4	Replace Incandescent Lighting With Fluorescent			160.5	161	$7,649	$88,515	$37,658	2.35
C3	Insulate Hot Water Storage Tanks	28.0	35.0	5.0	68	$510	$6,925	$3,334	2.08
D8	Improve Power Factor			46.6	47	$7,745	$106,444	$61,973	1.72
B15	Retrofit to Variable Air Volume			178.0	178	$3,246	$37,973	$25,848	1.47
B8	Replace Inefficient Chillers (See Note 2)			353.7	354	$49,554	$597,123	$426,488	1.40
B21	Replace Boiler		915.7		916	$7,206	$102,039	$77,778	1.31
B18	Add Zone Optimizer to Reheat Systems			15.1	15	$329	$3,849	$3,556	1.08
Totals for Recommended ECO's		3,643	5,478	2,416	11,537	$167,161	$2,152,191	$793,869	2.71

Notes:

1. ECO B4 is evaluated also for use of removable insulation; standard insulation is recommended and is displayed above.
2. Annual cost savings includes annualized nonrecurring cost savings.

Table 1-3
Summary of Analysis Results for ECO's Not Recommended

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	LCC $	Investment $	SIR
B14	Install Multizone Controls	88.0	32.0	396.0	516	$7,907	$94,047	$128,183	0.73
B11	Install Economizer Cycle for "Free" Cooling			323.4	323	$6,407	$74,959	$107,227	0.70
D3	Retrofit Exterior Lighting With HPS Fixtures (unit screening analysis)			3.9	4	$107	$1,229	$1,858	0.66
D10	Install FM Radio EMCS	2,460.0	3,399	1,841	7,700	$86,136	$1,102,103	$2,329,435	0.47
A1	Caulk and Weatherstrip Doors and Windows	1,435.0	670.0	94.2	2,199	$14,476	$68,581	$154,110	0.45
B3	Insulate Ductwork		5.4		5	$42	$593	$1,337	0.44
D5	Install Electronic Ballasts and T8 Lamps (unit screening analysis)			0.1	0	$4	$40	$94	0.43
B5	Install Outside Air Temperature Reset Controls	7.0			7	$28	$403	$1,231	0.33
A5	Install Solar Film on Windows			355.0	355	$7,753	$34,812	$117,382	0.30
B9	Install Heat Recovery System	58.0			58	$289	$3,980	$16,247	0.24
B2	Shade Refrigerant Condensers From Direct Sunlight			279.0	279	$2,386	$29,480	$187,624	0.16
A3	Insulate Exterior Walls	47.0	1.0	14.0	62	$547	$8,709	$116,161	0.07

Table 1-3 (Cont.)
Summary of Analysis Results for ECO's Not Recommended

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	LCC $	Investment $	SIR
A7	Install Shading Devices for Windows			17.0	17	$85	$394	$20,411	0.02
A2	Install Double Glazing	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
A6	Reduce Glass Area	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
C4	Install Electric Ignitors in Gas Hot Water Heaters	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
C6	Use Cold Water for Laundering	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
D1	Reduce Lighting Levels	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D2	Install Time Clocks on Exterior Lighting	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D6	Revise Transformer Loading	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D7	Improve Voltage Regulation	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D9	Replace Motors with High Efficiency Units	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							

2.0 Introduction

This final report contains the results of all work for the Limited Energy Study, Energy Engineering Analysis Program (EEAP), Fort Hunter Liggett, California. The work was authorized under contract number DACA05-92-C-0155 with the U.S. Army Corps of Engineers, Sacramento District, Sacramento, California.

2.1 Purpose

The purpose of this limited base-wide energy study is to develop a systematic plan for projects and actions that will reduce energy consumption and operating costs of the major facilities at Fort Hunter Liggett.

2.2 Scope

The scope of work as established by the U.S. Army Corps of Engineers, Sacramento District, consists of the following tasks:

- Limited site investigation of specific buildings and systems
- Review of previously completed energy studies
- Evaluation of specific energy conservation opportunities (ECOs) to determine economic feasibility
- Preparation of funding documentation for recommended ECO's
- Preparation of a comprehensive report documenting the data collected, analyses performed, and projects recommended

The complete scope of work, together with minutes of the pre-negotiation conference, is provided in Appendix A.

2.3 Methodology

This study is structured chronologically in three phases: site investigation, interim report preparation, and pre-final/final report preparation. Methodologies used at each phase of the study are addressed as follows:

2.3.1 Site Investigation

An entry briefing attended by the contractor (A/E), a representative of the Fort Hunter Liggett Directorate of Engineering and Housing (DEH), and the Energy Coordinator at Fort Ord was held prior to beginning the site investigation. Survey

schedules and support requirements from DEH were discussed; and energy usage summaries were obtained.

Field team members then inspected buildings and systems and recorded findings on the standard forms developed by the A/E for this purpose. Copies of available architectural, mechanical, and electrical building as-built drawings were obtained as well as appropriate utility and site plans.

An exit briefing was held at the completion of the field work. The purpose of the briefing was to report progress and to identify "quick fix" measures that could be readily implemented by the DEH. (Refer to Appendix A.)

2.3.2 Interim Report

The first step in preparation of the Interim Report was the compilation of building data bases for the survey population covering HVAC systems, domestic hot water systems, lighting and process equipment. A representative group of significant buildings were modeled with the Trane Air Conditioning Economics (TRACE) program to develop baseline energy usage and demand quantities. The model estimates were compared with actual historical data and model input parameters were adjusted as necessary to achieve reasonable closure.

Following completion of the building databases and energy models, potential energy conservation opportunities identified during the field survey were evaluated for each study building. Computer modeling, as described above, spreadsheet software and, where necessary, manual calculations were employed to determine the relative benefits of each ECO. Life cycle cost analyses (LCCA) were performed for all ECOs in accordance with the latest "Energy Conservation Investment Program (ECIP) Guidance."

The results of the ECO analyses were summarized into three listings as follows:

(1) All ECOs eliminated from consideration together with reasons for this determination.

(2) All ECOs that were analyzed and recommended, arranged in order of descending savings-to-investment ratio (SIR).

(3) All ECOs that were analyzed and not recommended, arranged in order of descending SIR.

2.3.3 Pre-final and Final Reports

Following the Interim Report presentation and review conference, funding documents will be prepared for combinations of viable ECOs as directed by the government

review. In addition, revisions resulting from the review conference will be incorporated into this document. For all projects with SIRs greater than 1.0, the following funding categories will apply:

- ECIP Project: Construction cost greater than $300,000; simple payback period less than ten years and savings-to-investment ratios shall be greater than 1.0.

- Regular Military Construction Army (MCA) Program: Construction cost greater than $300,000; simple payback period of 4 to 25 years.

- OSD Productivity Investment Funding (OSD PIF): Construction cost greater than $100,000; simple payback period of four years or less. (Not expected to be funded after FY93.)

- Productivity Enhancing Capital Investment Program (PECIP): Construction cost greater than $3,000 but less than $100,000; simple payback period of four years or less. (Not expected to be funded after FY93.)

- Quick Return on Investment Program (QRIP): Construction cost greater than $3,000 but less than $100,000; simple payback period of two years or less. (Not expected to be funded after FY93.)

- Low Cost/No Cost Projects: Projects that the DEH can perform with in-house resources or by contract.

3.0 Description of Installation

3.1 Location, Size and Climate

Fort Hunter Liggett is located in southern Monterey County, California, east of the coastal mountains and approximately 20 miles southwest of King City, as shown on Figure 3-1.

The reservation covers 164,762 acres (or 257.4 square miles) and includes the trailer town of Jolon within its boundaries. Most surveyed facilities are located in the headquarters area situated on the east side of the reservation, midway between the northern and southern boundaries. The elevation of the headquarters area is 1,080 feet.

The summer design dry and wet bulb temperatures are 99°F and 72°F, respectively. These are the temperatures equalled or exceeded 2 1/2 percent of the time, on the average, during the warmest four consecutive months (June through September). The dry bulb temperature exceeds 80°F an average of 1,511 hours per year and the wet bulb temperature exceeds 67°F an average of 493 hours per year during the six warmest months of the year.

The winter design dry bulb temperature is 26°F. This temperature is equalled or exceeded 2 1/2 percent of the time, on the average, during the coldest consecutive three months (December through February). Heating degree days (the difference between the mean daily temperature and a base temperature of 65°F), as listed in TM5-785 total 3,332 annually.

Since complete temperature bin data is not available for Fort Hunter Liggett, data for Paso Robles was used, but adjusted according to the total annual heating degree days listed in TM5-785. Details of the process used to create hourly weather data representative of Fort Hunter Liggett, together with a listing of such data, is provided in Appendix C.

3.2 Population and Building Summary

Based on the Space Utilization Report dated 25 June 1992, there are 205 numbered structures containing a total of 791,034 square feet of gross floor space. This limited energy study evaluates 52 surveyed buildings, with results extended to an additional 44 identical or similar buildings. Together these buildings contain a total of 623,386 gross square feet and account for approximately 93 percent of overall energy usage. Refer to Appendix F, Table F-1 for a listing of the model (audited), identical, and similar buildings, and buildings eliminated from consideration due to little or no energy use.

As of October 1992, the total daytime population of the base, including both military and civilian personnel was 1,000.

3.3 Description of Utility Systems

Electric power is supplied to Fort Hunter Liggett at 12 kV by Pacific Gas and Electric Company (PG&E) from its King City Substation, located approximately eight miles from Post Headquarters. An alternate 12 kV feeder extends about 43 miles to PG&E's San Miguel Substation. Electric power is distributed on-base via 12 kV aerial lines feeding both pole-mounted and pad-mounted transformers.

Propane is supplied by Northern Energy Company to approximately 70 liquid propane tanks serving specific facilities throughout the installation.

No. 2 fuel oil is supplied to storage tanks dedicated to hot water boilers located at 16 facilities throughout the installation.

There are no central energy plants at Fort Hunter Liggett. All buildings have their own heating, ventilating and air conditioning systems and domestic hot water heating systems. Summary data for these systems is provided in Appendix F.

3.4 Future Changes Planned or Anticipated

A summary of programmed military construction (MCA) projects for Fort Hunter Liggett as of October 1992 is provided in Table 3-2, including project scopes (square feet), fiscal year funds sources and estimated energy budgets. Note that all future construction projects have recently been placed on hold.

3.5 Historical Energy Consumption and Demand

Energy sources available at Fort Hunter Liggett facilities include:

- Electric power purchased from PG&E
- Vendor supplied No. 2 fuel oil
- Vendor supplied propane

Total recorded energy consumption at Fort Hunter Liggett in FY92 of non-transportation energy sources was about 79,728 million BTU's equivalent. This value includes electric power at 3,413 BTU per kWH, No. 2 fuel oil at 138,700 BTU per gallon and propane at 95,000 BTU per gallon. Total energy consumption per active square foot of building floor area is 100,800 BTU per square foot per year based on 791,034 active square feet as of October 1992.

Historical electricity usage and demand for the Headquarters Area of Fort Hunter Liggett for three fiscal years (FY90, 91, and 92) are shown graphically in Figures 3-2 and 3-3, respectively. The peaks of electricity usage shown in Figure 3-2 correspond to mechanical cooling load during the summer months and electric resistance heating during the winter months. Since little or no space cooling or heating is required during the months of May and November, a significant decline in electricity usage occurs during these two months. The peaks of electrical demand shown in Figure 3-3 also correspond to the high mechanical cooling loads during the summer months. During the months of on-peak demand billing (June through October), demand charges account for over 30 percent of the overall cost of power.

Figure 3-4 depicts heating fuel oil deliveries to Fort Hunter Liggett Cantonment Area facilities for the same three-year period. As expected, peak periods occur during the heating season. Note that the figure shows deliveries to fuel tanks used for space and domestic water heating systems. No records are available to show when the fuel is consumed; thus the peaks and valleys may not correspond to events which drive fuel use up or down.

Figures 3-5 and 3-6 depict electrical usage for the family housing buildings T-6 and T-376, the water well and range area for FY90, FY91, and FY92.

3.6 Review of Previous Energy Audit

A 1982 PG&E energy utilization audit of 35 buildings at Fort Hunter Liggett yielded a set of recommendations estimated to save the base 1.6 million kWH per year (or 17.4 percent of total electricity consumption) and 495 kW in electricity demand. Few, if any, of these recommendations were implemented in subsequent years.

This study re-evaluates all energy and cost saving measures recommended in the PG&E study in light of current technology, existing conditions in major Fort Hunter Liggett facilities, and current energy costs and utility rebate programs.

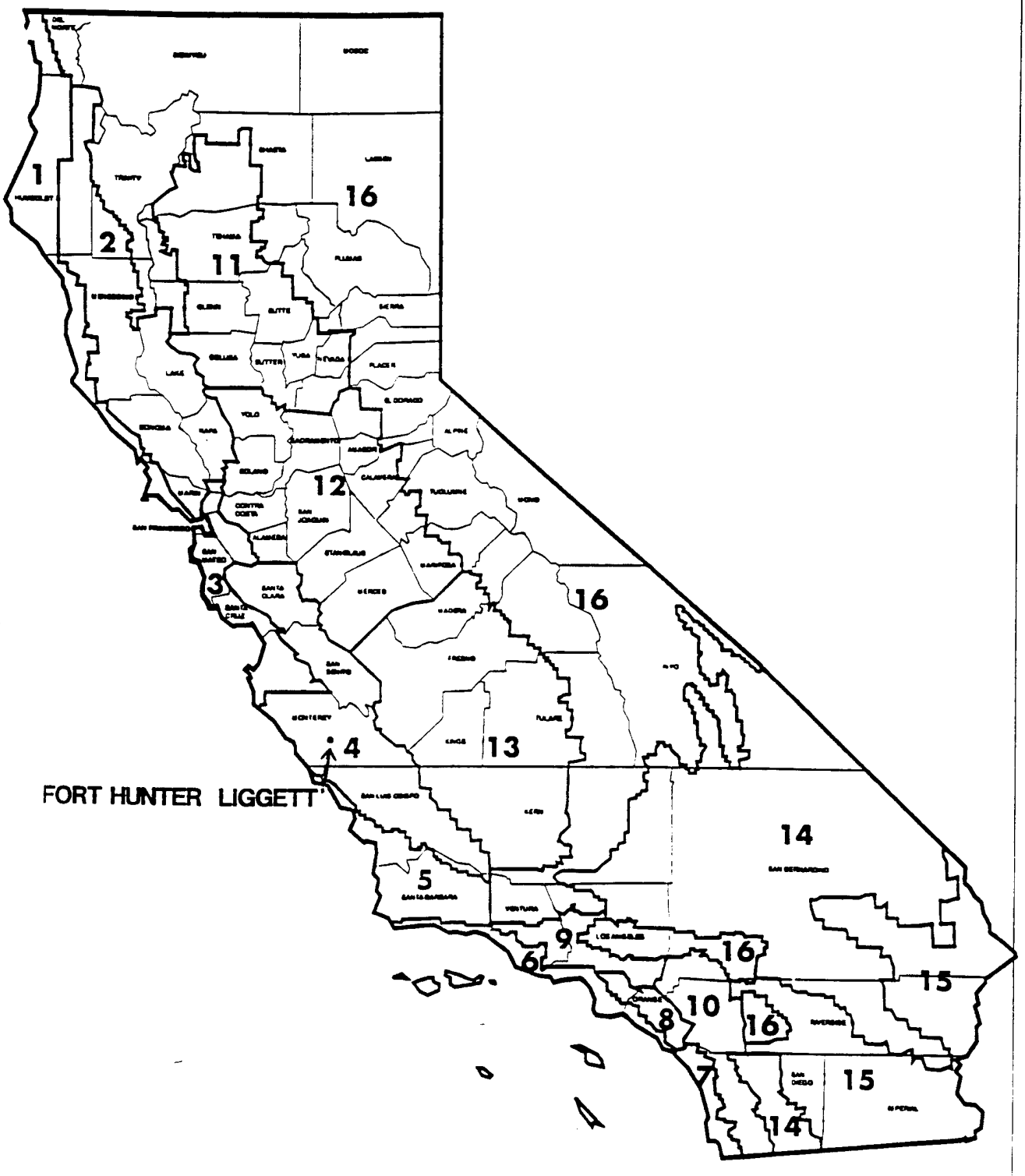

FIGURE 3-1
LOCATION MAP

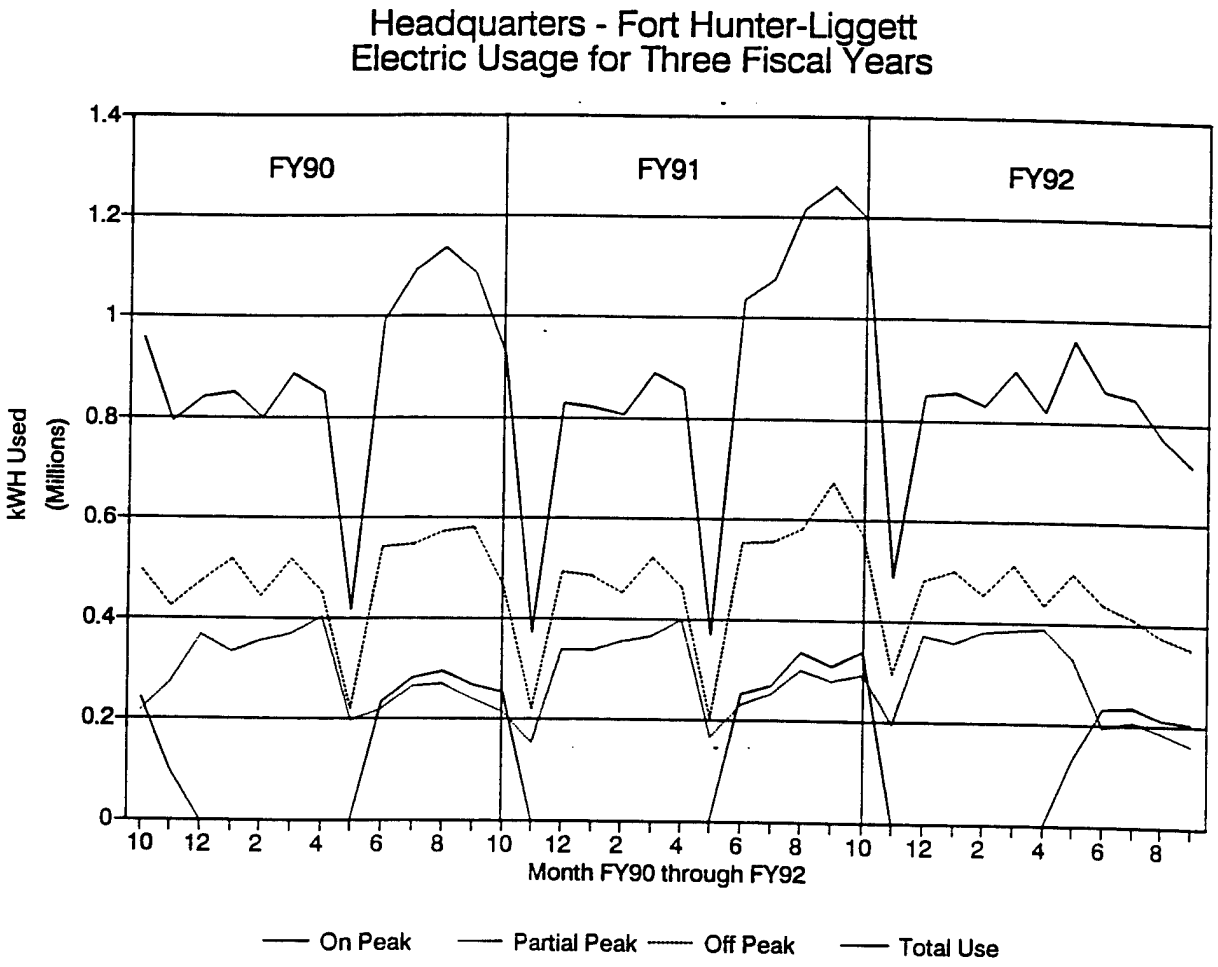
Headquarters - Fort Hunter-Liggett
Electric Usage for Three Fiscal Years
FY90
FY91
FY92
kWH Used
(Millions)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8
Month FY90 through FY92
On Peak
Partial Peak
Off Peak
Total Use

FIGURE 3-2

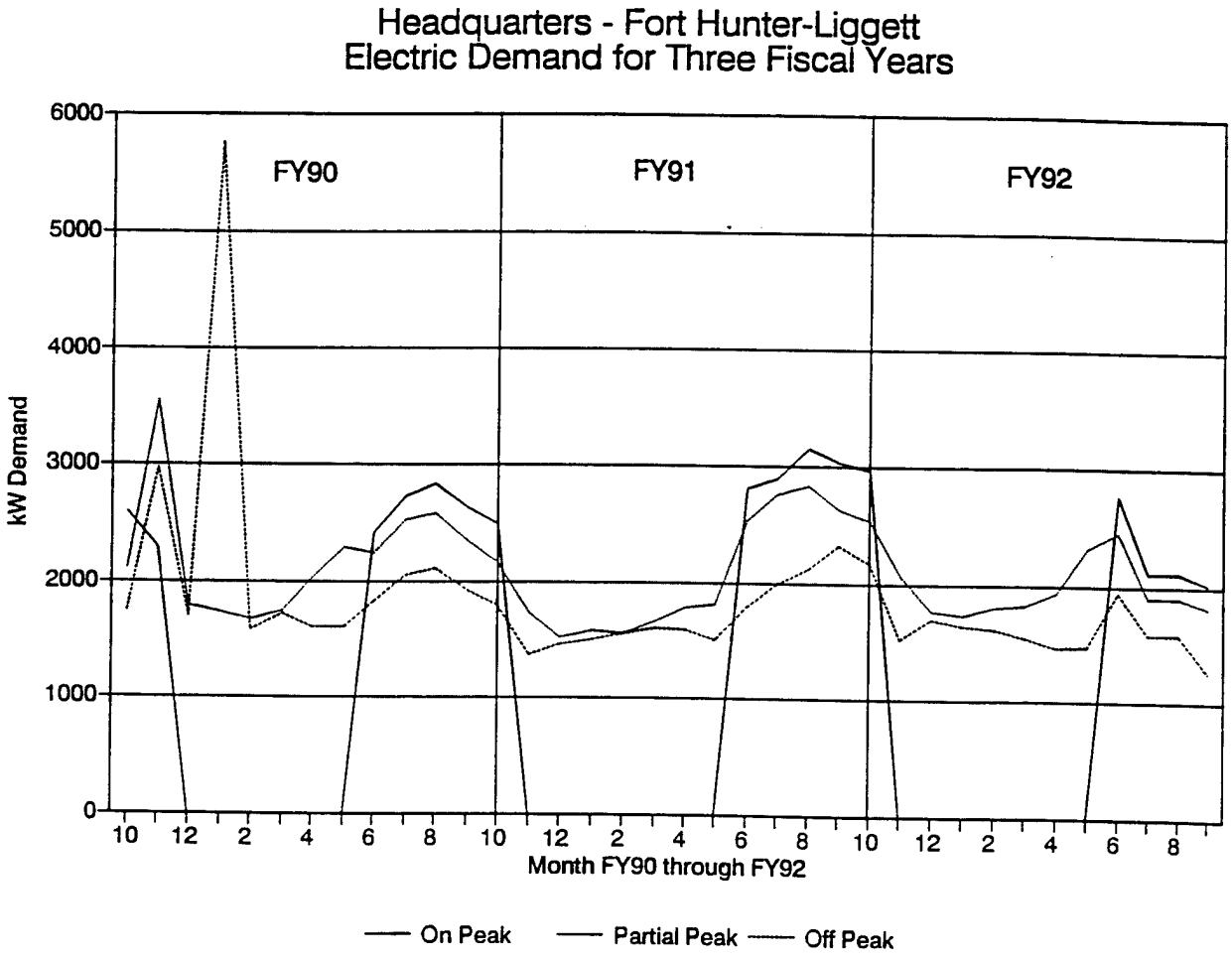
Headquarters - Fort Hunter-Liggett
Electric Demand for Three Fiscal Years
6000
5000
4000
3000
2000
1000
0
kW Demand
FY90
FY91
FY92
10
12
2
4
6
8
10
12
2
4
6
8
10
12
2
4
6
8
Month FY90 through FY92
On Peak
Partial Peak
Off Peak

FIGURE 3-3

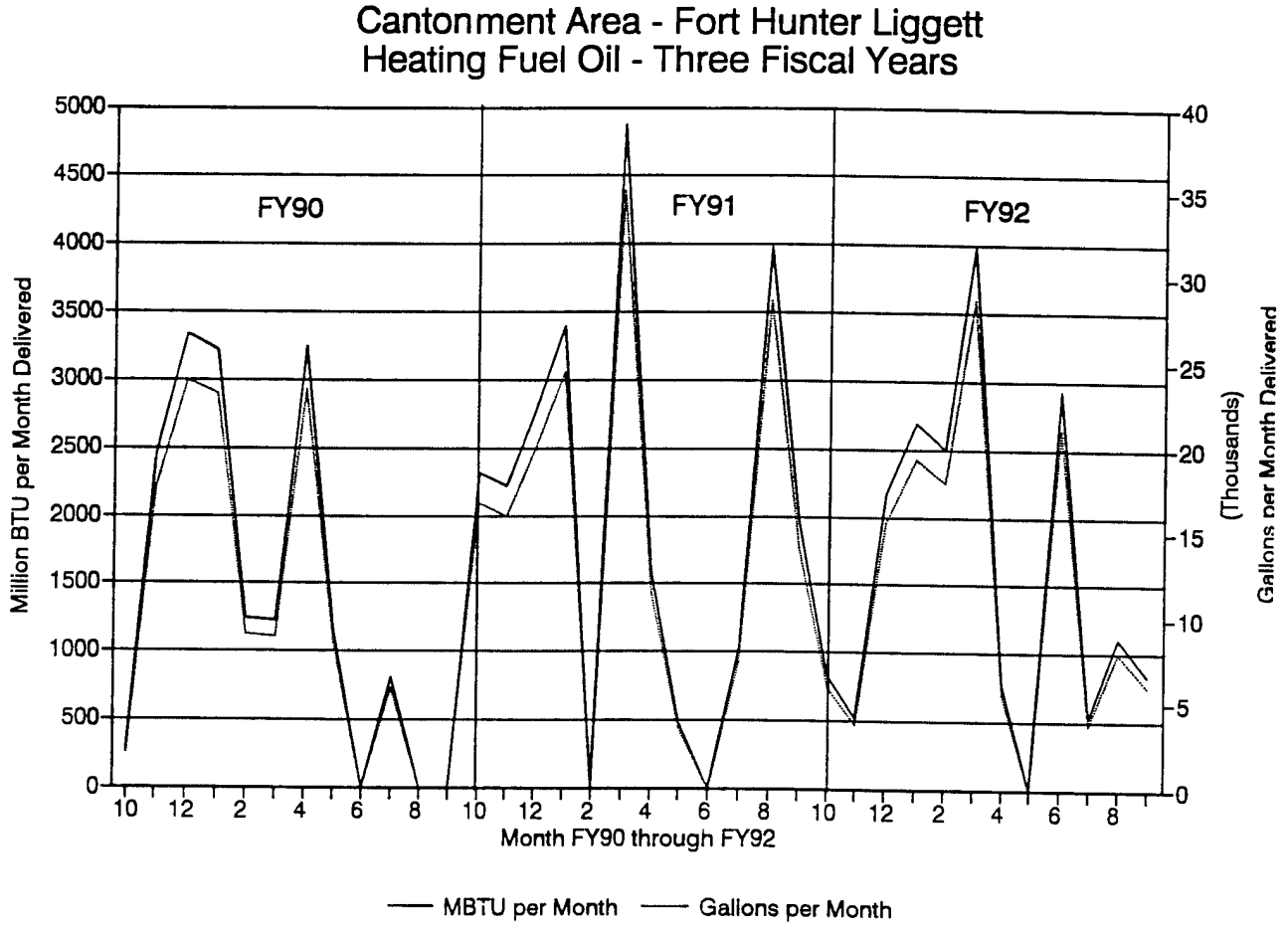
Cantonment Area - Fort Hunter Liggett
Heating Fuel Oil - Three Fiscal Years
FY90
FY91
FY92
Million BTU per Month Delivered
Gallons per Month Delivered (Thousands)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
40
35
30
25
20
15
10
5
0
10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8
Month FY90 through FY92
MBTU per Month
Gallons per Month

FIGURE 3-4

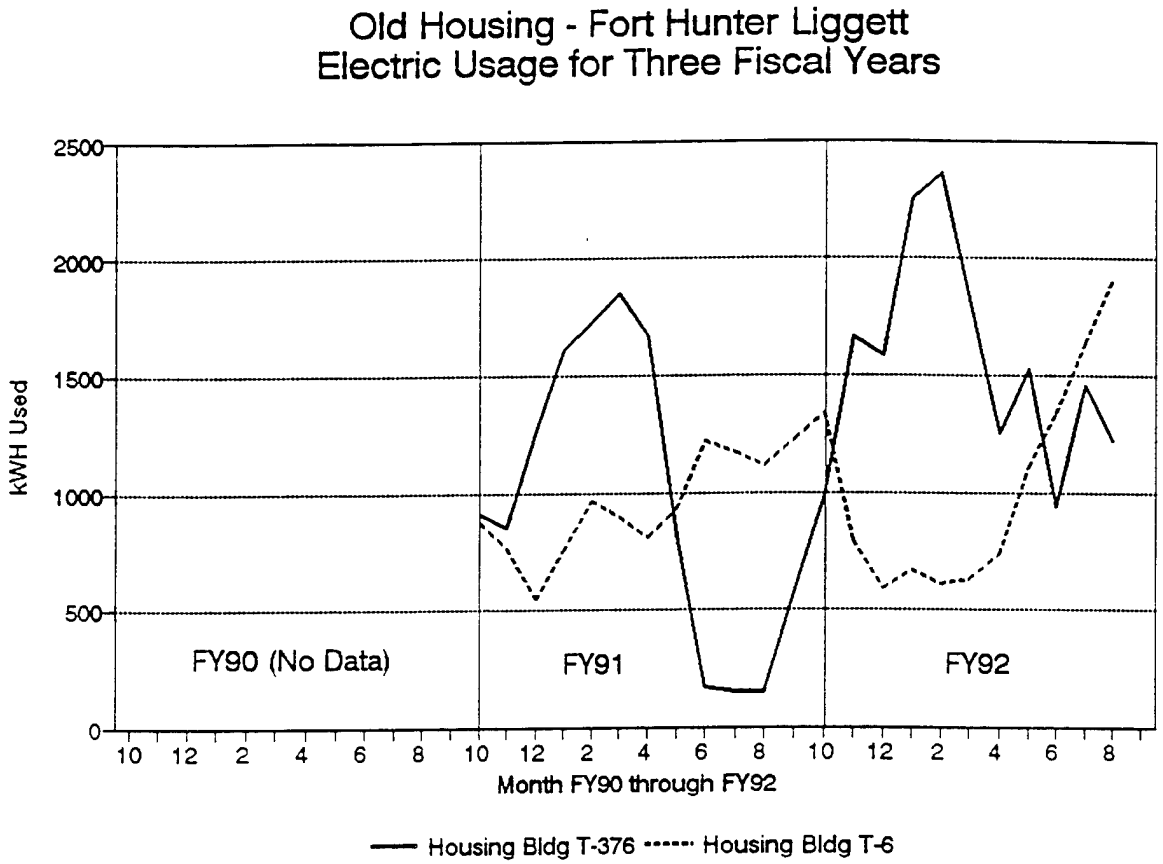
Old Housing - Fort Hunter Liggett
Electric Usage for Three Fiscal Years
kWH Used
2500
2000
1500
1000
500
0
FY90 (No Data)
FY91
FY92
10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8
Month FY90 through FY92
Housing Bldg T-376
Housing Bldg T-6

FIGURE 3-5

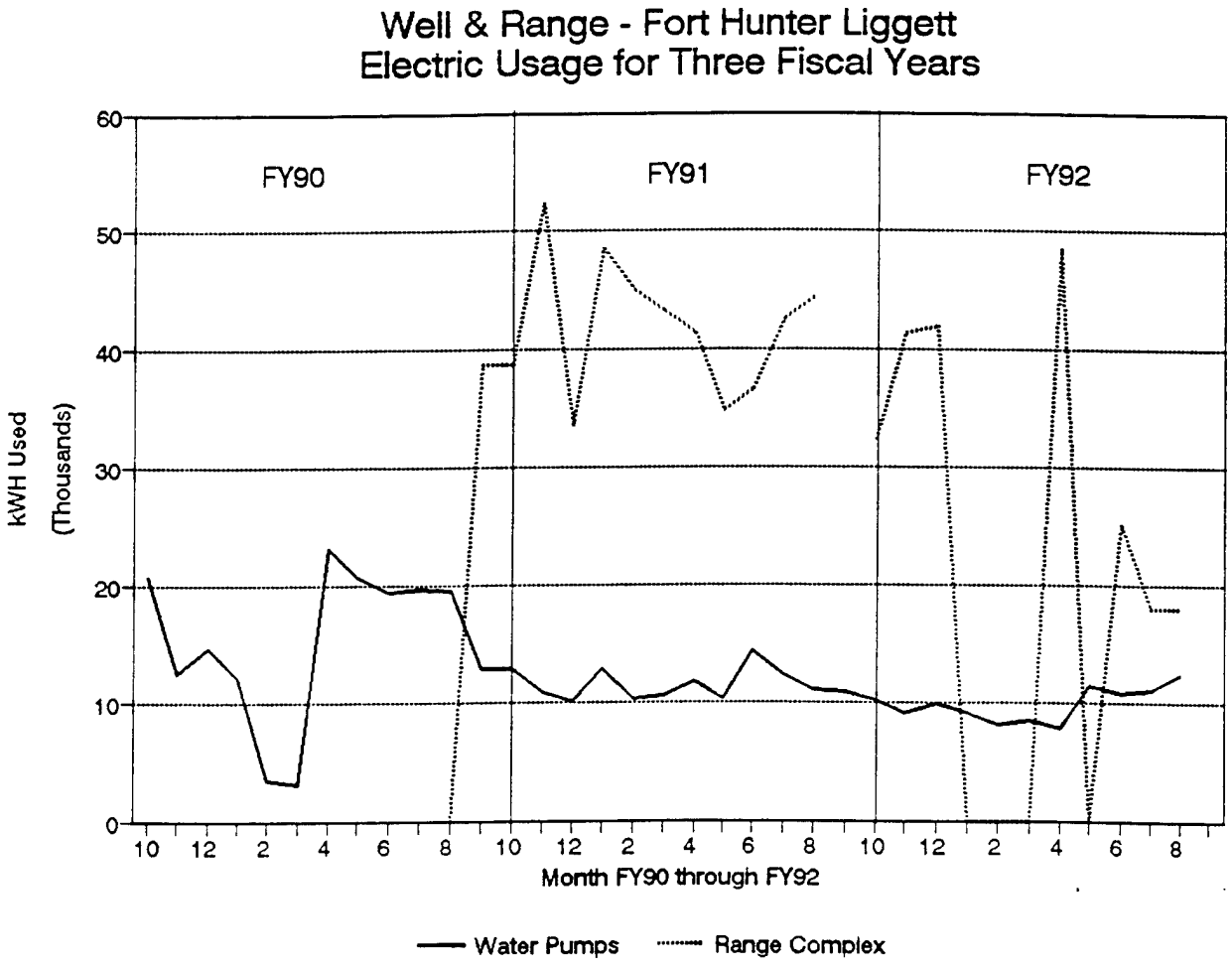
Well & Range - Fort Hunter Liggett
Electric Usage for Three Fiscal Years
FY90
FY91
FY92
kWH Used
(Thousands)
60
50
40
30
20
10
0
10 12 2 4 6 8 10 12 2 4 6 8 10 12 2 4 6 8
Month FY90 through FY92
Water Pumps
Range Complex

FIGURE 3-6

TABLE 3-1
Exterior Lighting Inventory[1]
Fort Hunter Liggett, California

Location	Lamp Type	No. Lamps	Lamp/ Ballast Watts	Connected Load kW
Barracks, Recreation Building, and ACES Areas	150W HPS 250W HPS 400W HPS	7 57 5	173 302 469	1.21 17.21 2.35
Bowling Center	175W MV 250W MV	4 2	197 285	.79 .57
Basketball & Volleyball Courts	400W HPS	16	469	7.50
Post Chapel	175W MV	1	197	.20
CDEC Storage	250W HPS	3	302	.91
Data Processing Complex	400W MV 250W HPS	12 4	469 302	5.63 1.21
Dental Clinic		5		
Facilities Engineer Area	175W HPS 500W Inc.	54 12	197 500	10.64 6.00
Family Housing Area	250W MV	11	285	3.14
Hacienda/Fire Station Area	175W MV 250W MV	13 5	197 285	2.56 1.43
Playing Field (Baseball/Football)	1000W Quartz	48	1000	48.00
PX and Theater	400W HPS	6	469	2.81
Tennis Courts	1000W Quartz	25	1000	25.00

[1]Not including building mounted exterior luminaires. Refer to Appendix F for data on building-mounted exterior fixtures.

Estimated usage:

Security/Street Lighting:	56.66 kW x .70 use factor x 4160 hrs/yr =	164,990 kWH
Play Field and Courts:	80.50 kW x 200 hours/year =	32,200 kWH
Total annual usage		197,190 kWH

TABLE 3-2
Summary of Construction Projects[1]
Fort Hunter Liggett, California

Description	Scope	Fiscal Year Funds Source	Status	Energy Budget 10^2 Btu/Year
Family Housing, 154 Units	183,550	FY92MCA		8,260
Child Development Center	5,600	FY92MCA		196
Youth Center	7,250	FY95MCA		435
Skill Development Center	3,400	FY95MCA	↑	136
Recreation Center	12,700	FY96MCA	On Hold	508
Guest House	6,120	FY96MCA	as of	245
Library	5,000	FY97MCA	9 March	200
Vehicle Wash	N/A	FY97MCA	1993	-
Unaccompanied Officers' Quarters	7,200	FY97MCA	↓	288
Centralized Fuel Point (Office Only)	512	FY97MCA		18
Ammunition Supply Point, 9 Igloos	21,000	FY97MCA		315

[1]Source: AFZW-DE, Fort Ord, CA
[2]Based on energy budgets per square feet in Table 11-1 of Architectural and Engineering Instructions, Design Criteria, dated 9 December 1991.

4.0 Energy Conservation Plan

4.1 Energy Balance

Baseline energy consumption in existing buildings was determined for various categories of end use both for fuel oil and electric power. Estimated consumption figures balanced with recorded fuel oil, propane, and electric power usage within approximately 10 percent, thus validating the baseline energy use calculations as the basis for evaluating savings from recommended projects.

Details of the procedures followed in creating the baseline estimates, together with building-by-building energy tabulations, are provided in Appendix B. The methods used to estimate energy consumption for each end use are summarized as follows:

Usage Type	Estimating Method
Space Heating, Cooling and Ventilation	a. TRACE 600 computer program for model buildings and manual calculations
Domestic Hot Water Heating	a. Consumption rates based on building function b. Measured temperatures c. Building occupancy d. DHW heating system efficiency
Lighting, Interior	a. Building fixture audits b. Demand factors based on building function c. Audited building schedules
Lighting, Exterior	a. Field audit data b. Demand factors based on building function c. Audited building schedules
Process	a. Consumption rates based on building function (12 categories) b. Dining facilities based on meals served and factors for steam or steam/electric cooking.

4.2 Projected Energy Consumption

Results of estimates prepared for the baseline and for projected energy consumption are summarized in Figure 4-1 and Figure 4-3 by end use. As shown, about 17.2 percent of baseline energy consumption can potentially be saved if recommended energy conservation measures are implemented. A breakdown by facility function is shown schematically in Figures 4-2 and 4-4 for baseline and projected energy consumption.

Tabular summaries of baseline energy consumption by end use and facility function are presented in Tables 4-1 and 4-2. Tabular summaries of projected energy consumption, after implementation of recommended conservation projects, by end use and facility function are presented in Tables 4-3 and 4-4. The summaries in Tables 4-1 through 4-4 do not include the effects of scheduled demolition, planned new construction, or possible changes in the mission of Fort Hunter Liggett. See Tables 4-5 and 4-6 for percentage of saving by facility and use.

4.3 Construction Cost Estimates

Construction costs are estimated for each energy conservation opportunity evaluated. Cost estimates may be considered at an order-of-magnitude level of accuracy. Labor and material costs are based predominantly on the 1993 Means Cost Estimating Guides with adjustments for geographic location and difficulty of retrofit work, as appropriate. Whenever feasible, budget quotes from equipment manufacturers have been used to improve accuracy.

Factors added to the subtotal of labor and materials costs include:

- General Conditions at 8 percent
- Contractor Overhead and Profit at 30 percent
- Bond at 1 percent
- Estimating Contingency at 10 percent

The resulting total probable construction costs are subsequently used in life cycle cost analyses.

4.4 Life-Cycle Cost Analysis Assumptions

4.4.1 Economic Assumptions

Economic analyses based on present worth techniques were performed for all potential energy conservation opportunities using the economic analysis form and procedures outlined in "Energy Conservation Investment Program (ECIP) Guidance" dated November 1992. The following assumptions and methods were used to develop standard input for economic analysis of all projects:

4.4.1.1 Investment costs include the following: Construction costs; contingency estimates at 10% of construction costs; supervision, inspection and overhead (SIOH) at 5.5% of construction costs; and design at 6% of construction costs. To compute total investment, the sum of the above costs was reduced by the amount of the expected utility rebate, if applicable.

4.4.1.2 The economic analysis was performed based on current (second quarter FY93) costs.

4.4.1.3 Discount factors and uniform present worth factors used in computing present values are obtained from the supplement to *NIST Handbook 135* entitled *Energy Prices and Discount Factors for Life-Cycle Cost Analysis 1992.* The discount rate set for 1993 by the Department of Energy is equivalent to a market rate of 7.9 percent. Allowing for an assumed rate of general price inflation yields a "real" discount rate of 4.0 percent. Uniform present factors (designated UPW*) using the 4.0 percent discount rate and adjusted for average fuel price escalation in the industrial sector for Census Region 4 are used in the analyses below.

4.4.1.4 The present value of recurring non-energy benefits and costs was obtained using a 0% differential rate and a 4.0 percent discount rate.

4.4.2 Energy Cost Assumptions

4.4.2.1 Electricity

Pacific Gas and Electric Company (PG&E) delivers electric power to Fort Hunter Liggett at a number of service points under several different rate schedules. The largest percentage of supplied power (over 90 percent) is metered at the Main Garrison under the firm, primary voltage rates in PG&E Schedule E-20. Since PG&E Schedule E-20 contains varying energy charges per kWH depending on the time of day and season, several weighted average rates were determined to be applied to energy cost savings calculations based on the timing of the expected savings. The three categories of savings rates -- (a) year-round day shift; (b) year-round, 24-hours; and (c) cooling season, 24-hours -- are determined as follows:

(a) Year-Round Day Shift Savings Rate

$$\text{Average Summer Savings Rate} = \frac{(6\ hrs \times SP) + (3.5\ hrs \times SPP) + (1.5\ hrs \times SOP)}{11\ hours}$$

$$= \frac{(6\ hrs \times \$0.10635) + (3.5\ hrs \times \$0.07218) + (1.5\ hrs \times \$0.05511)}{11\ hours}$$

$$= \$0.08849 \text{ per kWH}$$

$$\text{Average Winter Savings Rate} = \frac{(9.5\ hrs \times WPP) + (1.5\ hrs \times WOP)}{11\ hours}$$

$$= \frac{(9.5\ hrs \times \$0.06172) + (1.5\ hrs \times \$0.05345)}{11\ hours}$$

$$= \$0.06059 \text{ per kWH}$$

$$\text{Average Annual Day Shift Savings Rate} = \frac{(6\ mos \times \$0.08849) + (6\ mos \times \$0.06059)}{12\ months}$$

$$= \$0.07454 \text{ per kWH}$$

Where: SP is summer peak period rate
SPP is summer partial-peak period rate
SOP is summer off-peak period rate
WPP is winter partial-peak period rate
WOP is winter off-peak period rate

Annual Savings per kW = (12 mos x $3.40/kW) + (6 mos x $11.30/kW)
(Including Summer Peak Period Demand)

= $108.60 per kW per year

(b) Year-Round, 24-Hour Savings Rate

Summer Peak Period:	780 hrs/8760 hrs x $0.10635	= $0.00947
Summer Partial-Peak Period:	910 hrs/8760 hrs x $0.07218	= $0.00750
Summer Off-Peak Period:	2750 hrs/8760 hrs x $0.05511	= $0.01730
Winter Partial Peak Period:	1690 hrs/8760 hrs x $0.06172	= $0.01191
Winter Off-Peak Period:	2630 hrs/8760 hrs x $0.05345	= $0.01605
Total Year-Round, 24-Hour Savings Rate (Per kWH)		= $0.06223

(c) Cooling Season, 24-Hour Savings Rate

Summer Peak Period:	780 hrs/4440 hrs x $0.10635	= $0.01868
Summer Partial-Peak Period:	910 hrs/4440 hrs x $0.07218	= $0.01479
Summer Off-Peak Period:	2750 hrs/4440 hrs x $0.05511	= $0.03413
Total Cooling Season, 24-Hour Savings Rate (Per kWH)		= $0.06760

4.4.2.2 No. 2 Fuel Oil

The current cost of No. 2 fuel oil delivered to Fort Hunter Liggett is $4.98 per MBTU, or approximately $0.69 per gallon.

4.4.2.3 Propane

The current cost of propane delivered to Fort Hunter Liggett is $7.87 per MBTU, or approximately $0.75 per gallon.

4.4.2.4 Proposed Federal Energy Tax

On 17 February 1993, President Clinton proposed an energy tax of $0.12 per million BTU's. Since this tax has not yet been passed into law by Congress, the energy analysis savings rates are not increased to reflect the additional tax. Adding this tax to the savings rates would have little impact on the outcome of the life cycle cost analyses, as it translates to a 2.4 percent increase for fuel oil cost and a 1.9 percent increase for electricity rates.

4.4.3 Utility Rebate Programs

Energy conservation projects implemented by Fort Hunter Liggett qualify for rebates under the two options in PG&E's "Commercial, Industrial and Agricultural Retrofit Program: Retrofit Express Program and Retrofit Customized Program."

The Retrofit Express Program pays a fixed rebate, up to $300,000 maximum per account per year, for installing particular energy efficient equipment for air conditioning, refrigeration, food service, motor, or lighting applications. Current rebates provided by PG&E under the 1993 program that may be applicable to Fort Hunter Liggett are summarized in Table 4-7.

The Retrofit Customized Program pays $0.05 per KWH of the first year's projected savings up to 50 percent of direct project costs. The maximum total incentive amount for this program is $300,000 per account.

The energy benefits of projects under both programs must be guaranteed to PG&E for a period not less than five years.

PG&E's rebate program requires that qualifying energy conservation measures be installed and operating before a rebate payment is approved. PG&E will neither install nor assist in financing costs of energy conservation retrofits. The costs of the PG&E rebate program are built into the electrical rate structure.

4.5 Summary of Energy Conservation Opportunities Studied

A listing of all potential ECOs considered for implementation at the facilities surveyed, including those ECOs recommended previously in the 1982 PG&E Energy Audit, is presented in Table 4-8. Preliminary evaluation reduced the list somewhat. The reasons for elimination are provided with calculations of projects evaluated. Refer to Appendix D for analyses of all ECOs.

4.5.1 Architectural ECOs

ECO A1: Caulk and Weatherstrip: Outside air infiltration can be reduced if weather-stripping is installed or replaced on doors and windows. Caulking applied to cracks around window and door frames also decreases infiltration.

ECO A2: Install Double Glazing: Installation of an additional layer of glazing on existing single pane windows reduces heat transmission and infiltration.

ECO A3: Insulate Exterior Walls: Insulating exterior building walls reduces thermal transmission, resulting in heating and cooling energy savings. Analyses found in Appendix D are based on computer simulations of heating and cooling energy use. Evaluations are conducted assuming other ECOs such as B7, Setback Thermostats, are implemented.

ECO A4: Insulate Ceilings/Roofs: One of the largest sources of thermal transmission in a building is the roof. Insulating roofs or ceilings reduces thermal losses (and heat gain when cooling), thereby reducing energy consumption. Calculations of energy savings are based on computer simulations.

ECO A5: Install Solar Film: Installation of solar glazing films on windows reduces the solar heat gain, thus reducing the cooling load. However, winter heating loads will increase somewhat due to the reduced solar gain.

ECO A6: Reduce Glass Area: By reducing window sizes, thermal characteristics of walls are improved; the U-value is lowered, and solar gain is decreased, saving energy for heating and cooling.

ECO A7: Install Shading Devices: Installation of exterior shading baffles above windows reduces the solar heat gain thus reducing the cooling load. However, as with solar films, winter heating loads will increase somewhat due to the reduced solar gain.

4.5.2 Heating, Ventilating and Air Conditioning (HVAC) ECOs

ECO B1: Install Load Shedding System (Local Controllers): Heating and cooling system auxiliary equipment, including fans and pumps, may be cycled off approximately 10 minutes out of every hour without unduly affecting personnel comfort. A local programmable controller installed in the mechanical equipment room and interfaced to the appropriate starters is required.

This ECO was recommended previously by the 1982 PG&E Energy Audit.

ECO B2: Shade Condensers From Direct Sunlight: By shading condensing units from direct sunlight, condenser water setpoints may be obtained with reduced fan operation, thus saving energy.

ECO B3: Insulate Ductwork: Insulating supply and return ductwork exposed to outside air or located in mechanical equipment rooms will reduce thermal losses, thus saving energy.

ECO B4: Insulate Piping and Fittings: Heating and cooling system piping, which is not insulated and is located either outside or in mechanical rooms, is a source of thermal loss. Insulating this piping reduces loads on heating and cooling equipment.

ECO B5: Install Outside Air Temperature Reset: This project will modify hot water boiler controls to provide hot water circulation temperature resets based on outside air temperature. Energy is saved in distribution piping due to a lower temperature difference between the air and the piping, thus lowering the distribution losses.

ECO B6: Install Time Clocks: Cycling of HVAC equipment using programmable controllers is analyzed under ECO B1. Time clock functions, as appropriate, are evaluated with ECO B7.

ECO B7: Provide Night Setback/Setup: This project would replace existing standard thermostats with automatic setback/setup thermostats to control zone heating and cooling. Temperature setbacks during unoccupied periods will result in heating energy savings and reduced electricity usage due to reduced run time of auxiliaries. Time clock controls per ECO B6 are used, as appropriate, on some buildings.

ECO B8: Replace Inefficient Chillers: Replacing older inefficient chilling machines with new units having higher energy efficiency ratios (EERs) will reduce both electricity usage and demand.

ECO B9: Install Heat Recovery System: Refrigeration and air conditioning systems reject heat which can be recovered to heat domestic hot water. Proposed heat recovery systems involve installation of a bypass loop, interrupting the existing connection between compressors and condensers. Hot gasses are condensed by domestic hot water makeup.

ECO B10: Install Automatic Draft Damper Control: Installation of automatic damper control on fired equipment flues reduces cycling losses. Automatic dampers reduce heat loss through the flues between periods when burners are operating.

ECO B11: Install Economizer Cycle: Buildings with central air conditioning systems could benefit from the free cooling provided by an economizer. An economizer takes advantage of outside air that is cooler than the building's cooling set point temperature. Introducing this cool air into the air handling unit reduces the load on the cooling coil, thereby decreasing electrical consumption by the chiller.

ECO B12: Replace Inefficient Boiler or Burner: Completely replacing older inefficient boilers or retrofitting existing boilers with new efficient burners will decrease fuel oil consumption due to increased combustion efficiency.

ECO B13: Install Evaporative Precoolers: Indirect evaporative precooling, retrofitted on to the fresh air or return air supply of air handling units, will save energy by decreasing the compressor load through evaporative cooling.

ECO B14: Install Multizone Controls: Modifying controls on multizone units to minimize the temperature difference between the hot and cold decks, based on conditions in each zone, will reduce energy consumption.

ECO B15: Retrofit to Variable Air Volume: Since a modulating variable air volume system circulates only the air required under partial load conditions, the fan energy consumed is considerably less than with a constant volume, dual duct system.

ECO B16: Automate Summer/Winter Switchover: The existing system in Building 295 uses the same piping for both hot water in the winter and chilled water in the summer and requires manually repositioning valves to switch modes. Installation of deadband controls to prevent either heating or cooling between 65°F and 78°F outside air temperature and automating the switchover will save both energy and operating labor. This feature is incorporated into ECO B6/B7 evaluations.

ECO B17: Relocate Transformer: Relocating a 150 kVA dry-type transformer from the computer room in Building 301 to a non air-conditioned space will reduce the building cooling load necessitated by the transformer losses. This recommendation has been implemented as of May 1993.

ECO B18: Add Zone Optimizer to Reheat Systems: Modifying controls to adjust the cooling setpoint as high as possible while still satisfying the zone with the greatest load will minimize the reheat required by the other zone, thus reducing consumption of both cooling and heating energy.

ECO B19: Add Deadband Controls: Adding deadband controls will prevent simultaneous heating and cooling, as well as create a temperature range (65°F - 78°F) in which neither heating nor cooling takes place. This feature is incorporated into ECO B6/B7 evaluations.

ECO B20: Consolidate Food Storage: Consolidating food storage at a single location for all eating facilities permits refrigeration units to be removed from service at the smaller facilities, leaving only the local storage necessary for daily usage. Recommended by the 1982 PG&E audit, this measure has been implemented at Fort Hunter Liggett.

ECO B21: Install Boiler Oxygen Trim Controls: Installation of oxygen trim controls will increase boiler efficiency and reduce fuel consumption. None of the boilers at Fort Hunter Liggett are of sufficient capacity to justify this retrofit.

4.5.3 Domestic Hot Water (DHW) ECO's

ECO C1: Reduce Hot Water Temperatures: Domestic hot water temperatures in many buildings exceed the limits specified in Fort Ord Regulation 11-2. It is assumed that in-house DEH personnel will perform annual adjustments at the indicated buildings.

ECO C2: Insulate Hot Water Pipes: Heat is lost from uninsulated domestic hot water (DHW) system piping. The application of one-inch thick fiberglass insulation and an aluminum jacket is evaluated in this ECO.

ECO C3: Insulate Hot Water Storage Tanks: Conduction losses from DHW heater and storage tank surfaces represent a significant amount of DHW heating energy use. The application of insulation is evaluated for all domestic water heaters. Uninsulated storage tanks and tanks with deteriorated insulation are also evaluated. Proposed retrofits include DHW fiberglass insulation blankets with vinyl or all-service jackets (depending on size) and fiberglass insulation with aluminum jackets for storage tanks. The analysis is conducted assuming ECO C1 is already implemented.

ECO C4: Install Electrical Ignitors In Gas Hot Water Heaters: Replacing gas pilots with electrical ignitors in gas hot water heaters will eliminate the 8760-hour per year consumption of the gas pilots; a slight increase in electricity consumption will result from the ignitors.

ECO C5: Install Aerators/Flow Restrictors in Lavatories and Showers: Installation of aspirators on lavatory faucets is recommended for barracks and quarters buildings, gyms and recreation facilities, schools, family housing, offices and in clubs. Aspirators reduce the amount of water used by a faucet to about 25 percent of the flow without an aspirator. The function is unimpaired. Significant savings in energy are achieved by reducing the amount of hot water used.

Installation of flow restricting shower heads is evaluated for barracks, quarters, gymnasiums, and medical clinics. A flow restricting shower head uses about 60 percent of the water a standard model uses; thus, energy is saved by reducing hot water consumption.

ECO C6: Use Cold Water For Laundering: Detergents that clean effectively with cold water have long been available, obviating the need to heat water for laundering purposes.

ECO C7: Replace Electric Booster For Garbage Can Washer: The electric booster heater for the garbage can washer at Building 206 adds 58.5 kW to the base's demand during its use. The costly electrical demand charges would be eliminated if the electric booster were replaced with heating hot water from the existing boiler. The booster heater has been disconnected by DEH as of May 1993.

ECO C8: Recover Heat From Dishwasher Hot Water: Commercial-type dishwashers heat water to about 180°F and then discharge the water to the sewer. Recovery of about 75 percent of this wasted heat is possible by installation of commercially available heat recover units. These units are designed to fit easily under existing kitchen counters.

4.5.4 Lighting, Electrical and EMCS ECO's

ECO D1: Reduce Lighting Levels: No building audited contained areas with footcandle levels well above those recommended in the current guidelines. Minor over-illumination delamping is not justifiable economically.

ECO D2: Install Time Clocks on Exterior Lighting: Most existing exterior lighting is activated and deactivated by photocell. Adding time clocks to control luminaries not necessary for site security or safety will permit reducing exterior lighting between midnight and dawn. Fort Hunter Liggett has recently revised exterior lighting, delamping a number of fixtures. Remaining building-mounted lighting is needed for security purposes.

ECO D3: Retrofit Exterior Lighting With High Pressure Sodium Fixtures: Considerable energy savings are generated by replacing inefficient incandescent, mercury vapor floodlighting and streetlighting fixtures with high pressure sodium fixtures. Energy savings are proportional to the lamp lumen efficiencies listed in the following table:

Lamp Type	Range in Lumens/Watt Input
Incandescent Flood	12-20
Mercury Vapor	40-50
High Pressure Sodium	65-90

ECO D4: Replace Incandescent Lighting With Fluorescent: The measure would replace existing inefficient incandescent fixtures with efficient compact fluorescent fixtures or four foot fixtures with electronic ballasts and T8 lamps. Recommended replacements are as follows:

Existing Incandescent	Replacement Fluorescent
50-60	13W/7T4 Quad.
75-100	18W/7T4 Quad.
150-200	F32/T8
250-300	2-F32/T8

ECO D5: Install Electronic Ballasts and T8 Lamps: Retrofitting existing fluorescent fixtures with electronic ballasts and T8 lamps will reduce fixture input power by 25 watts in standard core and coil ballasts and 11 watts in energy-saving core and coil ballasts for 2-lamp fixtures.

ECO D6: Revise Transformer Loading: For maximum efficiency, a transformer should be operated at a per unit kVA load (L) determined from the transformer's Loss Ratio (R) by the following equation:

$$L = \frac{1}{\sqrt{R}}$$

Since the Loss Ratio (R) of most distribution transformers falls in the range of 2.5 to 5, the most efficient loading is 0.44 to 0.63 per unit kVA. Since most transformers at Fort Hunter Liggett fall within this range, this ECO is not applicable.

ECO D7: Improve Voltage Regulation: Indicating voltage measurements taken during the site survey fell within the range allowed by ANSI Standard C84-1 of 91.7% to 105.8% of nominal system voltage (for an unregulated system). Addition of power factor correction capacitors at the loads (ECO D8) will help to improve voltage regulation. No further development of this ECO is provided.

ECO D8: Improve Power Factor: Installation of power factor correction capacitors at the main utility metering point will reduce billing penalties only and not improve the load capability of the distribution system. Installation of capacitors at individual motor loads will free up system capacity by reducing the amount of magnetizing current drawn through the distribution system.

ECO D9: Replace Motors With High Efficiency Units: The incremental cost of replacing failed or failing electric motors with high or premium efficiency units rather than standard units is nearly always justified. As an added incentive, PG&E rebate levels average 2-1/2 times higher for premium efficiency motor retrofits. Replacing standard motors in good condition, however, requires both high efficiency gains and high operating hours to be justified economically.

A screening analysis for replacing existing standard efficiency motors with premium efficiency units revealed that the break-even operating hours ranged from over 100,000

hours per year for a 1 HP motor retrofit to over 50,000 hours for a 20 HP motor retrofit. Therefore, replacing existing standard motors with high-efficiency units is not recommended unless the standard motor has failed or failure is imminent.

ECO D10: Install FM Radio EMCS: Refer to Section 8.0 for a feasibility analysis of a base-wide FM radio EMCS.

4.6 Recommended Energy Conservation Projects

A summary of analysis results for recommended ECOs is provided In Table 4-9; and a summary of analysis results for ECOs not recommended is provided in Table 4-10.

BASELINE ENERGY CONSUMPTION BY END USE

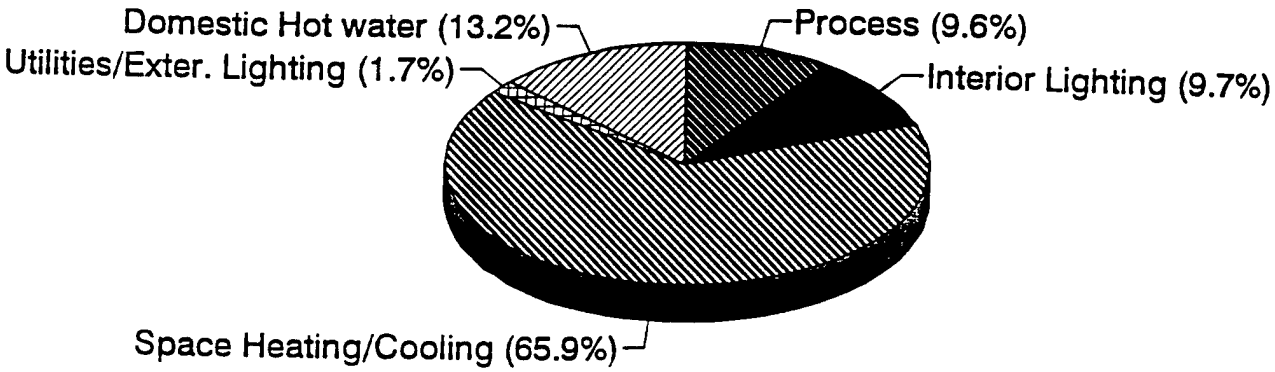

FIGURE 4-1

BASELINE ENERGY CONSUMPTION BY FACILITY

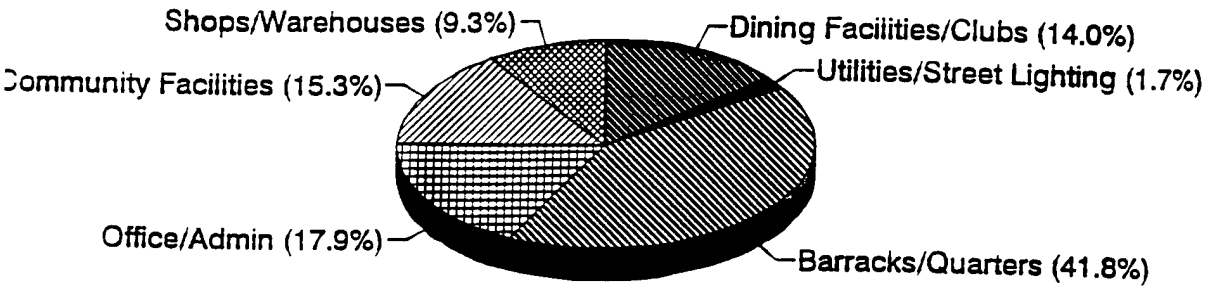

FIGURE 4-2

PROJECTED ENERGY CONSUMPTION BY END USE

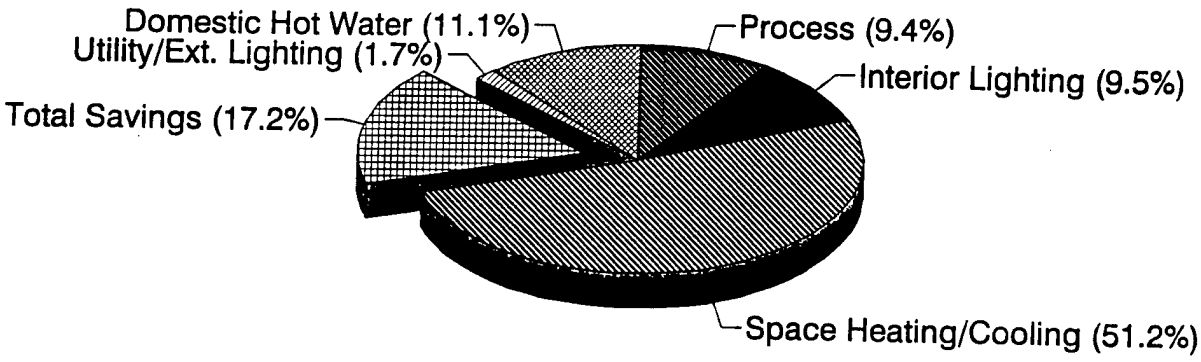

FIGURE 4-3

PROJECTED ENERGY CONSUMPTION BY FACILITY

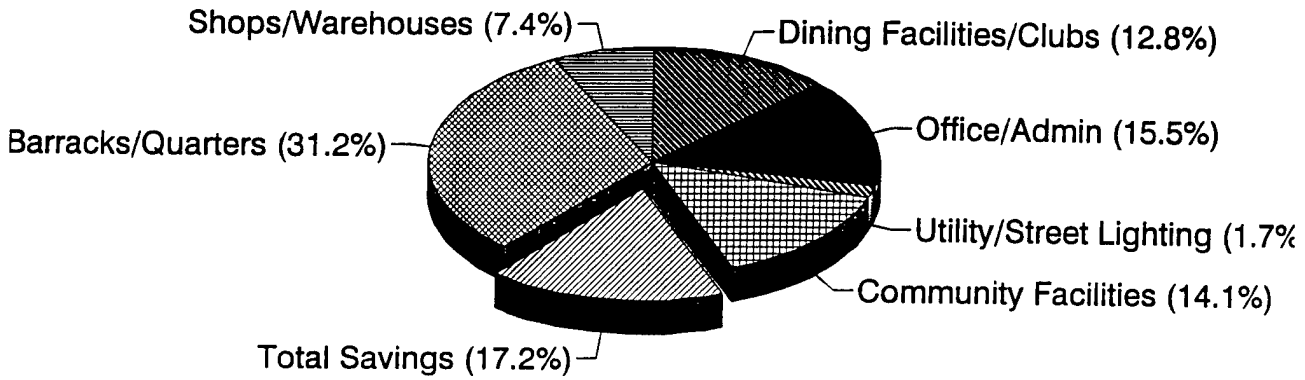

FIGURE 4-4

Table 4-1 Baseline Energy Consumption by End Use
Fort Hunter Liggett

Energy Use Category	Baseline Energy Use			
	Fuel Oil Mil BTU/Yr	Propane Mil BTU/Yr	Electric kW-Hr/Yr	Equivalent Mil BTU/Yr
Space Heating and Cooling	16,946	14,375	4,111,758	45,355
Domestic Hot Water	4,813	3,657	169,376	9,048
Process	0	305	1,839,150	6,582
Lighting, Interior	0	0	1,958,377	6,684
Lighting, Exterior and Utilities	0	0	333,430	1,138
Total Energy Use	21,759	18,337	8,412,091	68,806

Table 4-2 Baseline Energy Consumption by Facility Function
Fort Hunter Liggett

Energy Use Category	Baseline Energy Use				
	Fuel Oil Mil BTU/Yr	Propane Mil BTU/Yr	Electric kW-Hr/Yr	Equivalent Mil BTU/Yr	Equivalent k BTU/SF-Yr
Offices and Administration	1,952	3,194	2,099,565	12,312	85.2
Shops and Warehouses	2,332	2,191	547,811	6,392	70.6
Barracks and Quarters	9,266	7,767	3,430,337	28,741	97.9
Community Facilities	3,358	3,448	1,099,831	10,560	170.3
Dining Facilities and Clubs	4,851	1,737	901,117	9,663	277.0
Utilities and Street Lighting	0	0	333,430	1,138	-
Total Energy Use	21,759	18,337	8,412,091	68,806	110.0

Table 4-3 Future Energy Consumption by End Use
Fort Hunter Liggett

Energy Use Category	Future Energy Use			
	Fuel Oil Mil BTU/Yr	Propane Mil BTU/Yr	Electric kW-Hr/Yr	Equivalent Mil BTU/Yr
Space Heating and Cooling	13,735	9,988	3,364,812	35,207
Domestic Hot Water	4,107	3,132	109,763	7,614
Process	0	304.5	1,806,662	6,471
Lighting, Interior	0	0	1,911,353	6,523
Lighting, Exterior and Utilities	0	0	333,430	1,138
Total Energy Use	17,843	13,424	7,526,020	56,953

Table 4-4 Future Energy Consumption by Facility Function
Fort Hunter Liggett

Energy Use Category	Future Energy Use				
	Fuel Oil Mil BTU/Yr	Propane Mil BTU/Yr	Electric kW-Hr/Yr	Equivalent Mil BTU/Yr	Equivalent k BTU/SF-Yr
Offices and Administration	1,412	2,633	1,948,338	10,695	66.3
Shops and Warehouses	1,886	1,466	510,293	5,093	56.3
Barracks and Quarters	6,546	5,068	2,883,429	21,455	73.1
Community Facilities	3,277	2,873	1,050,304	9,735	157.0
Dining Facilities and Clubs	4,722	1,384	800,226	8,836	253.3
Utilities and Street Lighting	0	0	333,430	1,138	-
Total Energy Use	17,843	13,424	7,526,020	56,953	91.1

Table 4-5 Percent Energy Savings by End Use
Fort Hunter Liggett

Energy Use Category	Future Energy Use			
	Fuel Oil Mil BTU/Yr	Propane Mil BTU/Yr	Electric kW-Hr/Yr	Equivalent Mil BTU/Yr
Space Heating and Cooling	18.9%	30.5%	18.2%	22.4%
Domestic Hot Water	14.7%	14.4%	35.2%	15.9%
Process	0.0%	0.0%	1.8%	1.7%
Lighting, Interior	0.0%	0.0%	2.4%	2.4%
Lighting, Exterior and Utilities	0.0%	0.0%	0.0%	0.0%
Total Energy Use	18.0%	26.8%	10.5%	17.2%

Table 4-6 Percent Energy Savings by Facility Function
Fort Hunter Liggett

Energy Use Category	Future Energy Use				
	Fuel Oil Mil BTU/Yr	Propane Mil BTU/Yr	Electric kW-Hr/Yr	Equivalent Mil BTU/Yr	Equivalent k BTU/SF-Yr
Offices and Administration	27.6%	17.6%	7.2%	13.1%	22.2%
Shops and Warehouses	19.1%	33.1%	6.8%	20.3%	20.3%
Barracks and Quarters	29.4%	34.8%	15.9%	25.4%	25.4%
Community Facilities	2.4%	16.7%	4.5%	7.8%	7.8%
Dining Facilities and Clubs	2.7%	20.3%	11.2%	8.6%	8.6%
Utilities and Street Lighting	0.0%	0.0%	0.0%	0.0%	-
Total Energy Use	18.0%	26.8%	10.5%	17.2%	17.2%

TABLE 4-7
Summary of 1993 PG&E Rebate Programs

Item Description	Rebate Amount
Air Conditioning Program	
Central A/C Units	
<65,000 Btuh, air-cooled split system	(new SEER - 10.0) x $35/ton
<65,000 Btuh, air-cooled single package	(new SEER - 9.9) x $65/ton
≥65,000 Btuh and <135,000 Btuh air-cooled, single package and split system	(new EER - 8.9) x $45/ton
≥135,000 Btuh and <760,000 Btuh air-cooled, single package	(new EER - 8.5) x $40/ton
≥135,000 Btuh, water and evaporative cooled, single package	(new EER - 9.6) x $45/ton
Package Terminal A/C Units	(new EER - min. EER) x $50/ton
Remote Condensing Units	
≥135,000 Btuh, air-cooled	(new EER - 9.9) x $20/ton
≥135,000 Btuh, water-cooled	(new EER - 12.9) x $25/ton
Water Chillers	
<150 tons, water-cooled	(new COP - 3.8) x $50/ton
≥150 and <300 tons, water-cooled	(new COP - 4.2) x $35/ton
≥300 tons, water-cooled	(new COP - 4.7) x $15/ton
<150 tons, air-cooled w/condenser	(new COP - 2.7) x $50/ton
≥150 tons, air-cooled w/condenser	(new COP - 2.5) x $35/ton
SEER = Seasonal Energy Efficiency Ratio EER = Energy Efficiency Ratio COP = Coefficient of Performance	
Evaporative Condensers	See Note 1
Cooling Towers	See Note 2
Early Replacement of Equipment (≥150 to 1000 tons)	(20 - age in years) x $2.50/ton
Misc. A/C Auxiliary Items	
Time Clock	$40/clock
Set-Back Programmable Thermostat	$45/thermostat
Bypass Timer	$10/timer
Reflective Window Film	$0.50/sq. ft.

TABLE 4-7
Summary of 1993 PG&E Rebate Programs

Item Description											Rebate Amount
Evaporative Cooler											$30/ton
Note 1 Evaporative condenser rebate matrix											
Approach temperature.*	20°F	19°F	18°F	17°F	16°F	15°F	14°F	13°F	12°F	11°F	10°F and lower
Incentive level $/chiller THR (tons).	$50	$55	$60	$65	$70	$80	$90	$100	$110	$120	$130
Note 2 Cooling tower rebate matrix											
Approach temperature.*	10°F	9°F	8°F	7°F	6°F	5°F	4°F and lower				
Incentive level $/chiller THR (tons).	$5	$10	$20	$30	$40	$60	$80				
* Degrees above 50.5% ASHRAE summer design wet-bulb temperature.											
Lighting Program											
Hardwired Compact Fluorescent Fixture											$ 15/fixture
Exit Sign Retrofit Kit											$ 7/fixture
LED Exit Sign											$ 15/fixture
Incandescent to Fluorescent Fixture Conversion											
with Energy-Saving Ballast											$ 15/fixture
with Electronic Ballast											$ 25/fixture
T-8, Electronic Ballast Fixture											
One-Lamp Fixture											$ 10/fixture
Two-Lamp Fixture											$ 25/fixture
Three-Lamp Fixture											$ 30/fixture
Four-Lamp Fixture											$ 35/fixture
T-8 (32 watt) Fluorescent Lamp											$ 1/lamp
Electronic Ballast											$ 5/lamp controlled
Fixture Efficiency Modification											
Removal of Lamp(s), Lamp Holders & Ballast(s)											
Two-Foot Lamp Removed											$ 5/lamp removed
Three-Foot Lamp Removed											$ 6/lamp removed
Four-Foot Lamp Removed											$ 8/lamp removed
Eight-Foot Lamp Removed											$ 12/lamp removed

TABLE 4-7
Summary of 1993 PG&E Rebate Programs

Item Description	Rebate Amount
Replacement of Lamp(s) & Ballast(s)	
Two-Foot Fixture	
Two-Foot T-8 or 18"-24" Compact	$ 7/lamp
Fluorescent Lamp & Electronic Ballast	replaced
Three-Foot Fixture	
Three-Foot T-8 or 25"-36" Compact	$ 4/lamp
Fluorescent Lamp & Electronic Ballast	replaced
Four-Foot Fixture	$ 6/lamp
Four-Foot T-8 Lamp & Electronic Ballast	replaced
Eight-Foot Fixture	$ 10/8' lamp
(2) Four-Foot T-8 Lamps & Electronic Ballast	replaced
High-Intensity Discharge (HID) Fixture	
Interior Fixture	
0 - 100 watt	$ 50/fixture
101 - 175 watt	$ 80/fixture
176 watt and greater	$100/fixture
Exterior Fixture	
0 - 100 watt	$ 30/fixture
101 - 175 watt	$ 40/fixture
176 watt and greater	$ 60/fixture
Time Clock	$ 25/check
Occupancy Sensor	
72 - 350 watts controlled	$ 15/sensor
351 - 1000 watts controlled	$ 31/sensor
1001 watts and greater controlled	$ 80/sensor
Bypass/Delay Timer	$ 10/timer
Photocell	$10/photocell

TABLE 4-8
Summary of ECO Evaluations
Fort Hunter Liggett, California

No.	Description of ECO	Recommended Project	SIR Less Than 1.0	DEH Maintenance	PG&E Project	N/A
	Architectural					
A1	Caulk and Weatherstrip		✓			
A2	Install Double Glazing					✓
A3	Insulate Exterior Walls		✓			
A4	Insulate Ceilings and/or Roofs	✓				
A5	Install Solar Film		✓			
A6	Reduce Glass Area					✓
A7	Install Shading Devises		✓			
	HVAC					
B1	Install Duty Cycling Controls	✓				
B2	Shade Condensers from Direct Sunlight		✓			
B3	Insulate Ductwork		✓			
B4	Replace Heating System Pipe Insulation	✓				
B5	Install Outside Air Temperature Reset		✓			
B6 B7	Install Time Clocks and Programmable Thermostats	✓				
B8	Replace Inefficient Chillers	✓				
B9	Install Heat Recovery System		✓			
B10	Install Automatic Flue Dampers on Heating System Boilers	✓				
B11	Install Economizer Cycle		✓			
B12	Install Boiler Oxygen Trim Controls and Revise Controls		✓			
B13	Install Evaporative Precoolers		✓		✓	
B14	Install Multizone Controls		✓		✓	
B15	Convert Multizone HVAC System to Variable Air Volume	✓			✓	
B16	Automate Summer/Winter Switchover	Evaluated as part of ECO B6/B7			✓	
B17	Relocate Transformer	✓		Done May 93	✓	
B18	Add Zone Optimizer to Reheat Systems		✓		✓	
B19	Add Deadband Controls	Evaluated as part of ECO B6/B7			✓	
B20	Consolidate Food Storage				✓	✓

TABLE 4-8
Summary of ECO Evaluations
Fort Hunter Liggett, California

No.	Description of ECO	Recommended Project	SIR Less Than 1.0	DEH Maintenance	PG&E Project	N/A
21	Replace Inefficient Boilers with Higher-Efficiency Boilers	✓				
	Domestic Hot Water (DHW)					
C1	Reduce Hot Water Temperatures	✓				
C2	Replace Pipe Insulation DWH Systems	✓				
C3	Insulate Hot Water Storage Tanks	✓				
C4	Install Electrical Ignitors in Gas Hot Water Heaters					✓
C5	Install Aerators/Flow Restrictors in Lavatories and Showers	✓				
C6	Use Cold Water for Laundering					✓
C7	Replace Electric Booster for Garbage Can Washer	✓		Disconnected by DEH	✓	
C8	Recover Heat from Dining Facility Dishwashing	✓				
C9	Install Automatic Draft Damper Controls on DHW Heaters	✓				
	Lighting and Electrical					
D1	Reduce Lighting Levels					✓
D2	Install Time Clocks on Exterior Lighting				✓	✓
D3	Retrofit Exterior Lighting with HPS Fixtures		✓		✓	
D4	Replace Incandescent Lighting with Fluorescent	✓			✓	
D5	Install Electronic Ballasts and T8 Lamps		✓			
D6	Revise Transformer Loading					✓
D7	Improve Voltage Regulation					✓
D8	Improve Power Factor	✓				
D9	Replace Motors with High Efficiency Units		✓	✓		
D10	Install FM Radio EMCS		✓			

Table 4-9
Summary of Analysis Results for Recommended ECO's

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	LCC $	Investment $	SIR
C7	Replace Electric Booster for Garbage Can Washer (Implemented by DEH)	(144.0)		102.0	(42)	$7,865	$90,526	$536	168.79
C1	Reduce Hot Water Temperatures (DEH O&M project)	430.0	578.0	199.2	1,207	$4,891	$74,457	$5,585	13.33
B6/B7	Install Time Clocks & Night Set Back/Setup	2,460	3,399	1,252	7,111	$53,286	$715,760	$66,368	10.79
B1	Install Load Shedding System (Local Controllers)			130.8 kW	130.8 kW	$14,122	$165,227	$26,187	6.03
C5	Install Aerators/Flow Restrictors in Lavatories and Showers		2.0	13.0	15	$250	$2,964	$501	5.91
C2	Replace Insulation on DHW Pipes and Fittings	48.0	15.0		63	$357	$4,968	$856	5.81
C9	Install Automatic Draft Damper Controls	51.0	31.0		82	$498	$6,954	$1,909	3.64
C8	Recover Heat From Dishwasher Hot Water	339.0			339	$1,528	$21,483	$6,510	3.30
B17	Relocate Transformer (Implemented by DEH)			21.5	22	$588	$8,540	$2,676	3.19
B10	Automatic Draft Damper Control on Space Heating Equipment	282.2	174.3		457	$2,777	$38,790	$14,561	2.66
A4	Insulate Ceilings/Roofs	88.0	289.0	69.0	446	$4,220	$71,904	$28,430	2.53
B4	Replace Insulation on Heating Piping and Fittings (See Note 1)	60.6	39.1	0.1	100	$540	$7,750	$3,115	2.49

Table 4-9 (Cont.)
Summary of Analysis Results for Recommended ECO's

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	LCC $	Investment $	SIR
D4	Replace Incandescent Lighting With Fluorescent			160.5	161	$7,649	$88,515	$37,658	2.35
C3	Insulate Hot Water Storage Tanks	28.0	35.0	5.0	68	$510	$6,925	$3,334	2.08
D8	Improve Power Factor			46.6	47	$7,745	$106,444	$61,973	1.72
B15	Retrofit to Variable Air Volume			178.0	178	$3,246	$37,973	$25,848	1.47
B8	Replace Inefficient Chillers (See Note 2)			353.7	354	$49,554	$597,123	$426,488	1.40
B21	Replace Boiler		915.7		916	$7,206	$102,039	$77,778	1.31
B18	Add Zone Optimizer to Reheat Systems			15.1	15	$329	$3,849	$3,556	1.08
Totals for Recommended ECO's		3,643	5,478	2,416	11,537	$167,161	$2,152,191	$793,869	2.71

Notes:

1. ECO B4 is evaluated also for use of removable insulation; standard insulation is recommended and is displayed above.
2. Annual cost savings includes annualized nonrecurring cost savings.

Table 4-10
Summary of Analysis Results for ECO's Not Recommended

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $ / Yr	LCC $	Investment $	SIR
B14	Install Multizone Controls	88.0	32.0	396.0	516	$7,907	$94,047	$128,183	0.73
B11	Install Economizer Cycle for "Free" Cooling			323.4	323	$6,407	$74,959	$107,227	0.70
D3	Retrofit Exterior Lighting With HPS Fixtures (unit screening analysis)			3.9	4	$107	$1,229	$1,858	0.66
D10	Install FM Radio EMCS	2,460.0	3,399	1,841	7,700	$86,136	$1,102,103	$2,329,435	0.47
A1	Caulk and Weatherstrip Doors and Windows	1,435.0	670.0	94.2	2,199	$14,476	$68,581	$154,110	0.45
B3	Insulate Ductwork		5.4		5	$42	$593	$1,337	0.44
D5	Install Electronic Ballasts and T8 Lamps (unit screening analysis)			0.1	0	$4	$40	$94	0.43
B5	Install Outside Air Temperature Reset Controls	7.0			7	$28	$403	$1,231	0.33
A5	Install Solar Film on Windows			355.0	355	$7,753	$34,812	$117,382	0.30
B9	Install Heat Recovery System	58.0			58	$289	$3,980	$16,247	0.24
B2	Shade Refrigerant Condensers From Direct Sunlight			279.0	279	$2,386	$29,480	$187,624	0.16
A3	Insulate Exterior Walls	47.0	1.0	14.0	62	$547	$8,709	$116,161	0.07

Table 4-10 (Cont.)
Summary of Analysis Results for ECO's Not Recommended

ECO No.	Description of ECO	Energy Savings: Fuel Oil MBTU/Yr	Propane MBTU/Yr	Electric MBTU/Yr	Total Equiv. MBTU/Yr	Cost Savings $/Yr	Cost Savings LCC $	Investment $	SIR
A7	Install Shading Devices for Windows			17.0	17	$85	$394	$20,411	0.02
A2	Install Double Glazing	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
A6	Reduce Glass Area	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
C4	Install Electric Ignitors in Gas Hot Water Heaters	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
C6	Use Cold Water for Laundering	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							
D1	Reduce Lighting Levels	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D2	Install Time Clocks on Exterior Lighting	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D6	Revise Transformer Loading	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D7	Improve Voltage Regulation	ECO was deemed not justified through screening analysis. (Refer to text for complete explanation)							
D9	Replace Motors with High Efficiency Units	ECO was deemed not justified through screening analysis. (Refer to text and Appendix D for complete explanation)							

5.0 FEASIBILITY OF NEW NATURAL GAS SERVICE

Natural gas has not been utilized as an energy source at Fort Hunter-Liggett to date, due to the fact that there is no natural gas pipeline at the site.

The closest natural gas pipeline in the southern portion of Monterey County is located along Route 101 at a distance of approximately 20 miles from the town of Jolon, California. The distance from Jolon to the Fort is another 7 miles. In 1989, a PG&E (window evaluation) study was done that estimated the installation of a natural gas branch main to Fort Hunter-Liggett had a construction cost of 2.6 million dollars. This estimated cost should be escalated to at least 3 million dollars for construction in 1993 based on the analysis developed further in this section.

The use of natural gas as an energy source can be reviewed for both heating and cooling requirements at Fort Hunter-Liggett. Gas fired chiller equipment or steam boilers for steam driven absorption chillers would be a consideration if there was a central chiller plant at the Fort now, or if one was planned in the immediate future. The Fort is presently using point-of-use cooling with individual chilling equipment which is the most advantageous based on the current site layout.

The use of natural gas for heating would replace existing fuel oil and propane energy sources and is estimated at an annual requirement of 612,526 therms.

The cost of PG&E gas is based on a rate of $.25 per therm for interruptible service, which would be totally unacceptable fuel source to the Army, or a uninterruptible service rate of $.55 per therm. The PG&E (window evaluation) study of projects is based on annual dollar volume generated in 1 to 3 years for modernization upgrade projects or up to 5 years for development of a totally new site. The utility would invest a designated portion of the income from the window period as their amount of effort for the project and the client/user would be responsible for the remainder of the construction/installation costs. PG&E's investment is estimated as follows:

621,928 Therms/Year x $.55/Therm x 3 Years x 0.7 = $718,326

An estimated example at Fort Hunter-Liggett based on these evaluations would be an investment of .7 million dollars by PG&E for a 70% allocation of three years revenue and a 2.3 million dollar investment by the DOD to bring the Utility company's gas pipe to Fort Hunter-Liggett.

The feasibility of natural gas service is not a viable consideration for the Fort based on a review of the demand, location of gas main and construction costs when compared to the annual O&M savings of natural gas. Refer to Table 5-1 for an economic evaluation of this conversion.

TABLE 5-1

ECONOMIC EVALUATION OF THE CONVERSION OF EXISTING FUEL TYPES TO NATURAL GAS

ENERGY FACTS PER CORPS OF ENGINEERS

No. 2 Fuel Oil = 138,700 BTU's per gallon

LP Gas (Propane) = 95,000 BTU's per gallon

Natural Gas = 100,000 BTU's per therm

FORT Hunter-Liggett DATA

1. Fuel Oil Usage = 288,000 gallons per year
   or 39, 946 x 10^6 BTU/YR

2. LP Gas Usage = 234,181 gallons per year
   or 21,451 x 10^6 BTU/YR

3. Fuel Oil Costs = 288,000 x $.69/GAL = $198,720 Year

4. LP Gas Costs = 234,181 x $.96/GAL = $224,814 Year

The conversion of actual gallons used of fuel oil and propane back to BTU's will provide a BTU's/YR total usage which can then be divided by 100,000 BTU's per therm to calculate the usage per year in therms, if the Fort was all natural gas usage for heating.

$$\text{(NG) Therms/YR} = \frac{(288{,}000)(138{,}700)}{100{,}000} + \frac{(234{,}181)(95{,}000)}{100{,}000}$$

(NG) Therms/YR = 399,456 + 222,472 = 621,928 Total

(NG) Annual Cost = 621,928 x $.55* = $342,060

* The rate used, $.55/Therm, is for uninterrupted service per PG&E.

TABLE 5-1 (Continued)

Annual Cost Savings	=	Annual Cost (FO) + (Propane)	- Annual Cost (Nat. Gas)
Annual Cost Savings	=	$198,720 + $224,814 - $342,060	
Annual Cost Savings	=	$81,474/Year Operation (Nat. Gas use)	

The annual maintenance cost savings will be in reduced manhours by less burner maintenance and pipe system monitoring. The existing annual manhour budget is 532 hours at a $21.00 rate for $11,172.00 the reduction of 50% of these hours would result in a maintenance savings of $5,586.00.

The total estimated annual O&M savings is $81,474 + $5,586 = $87,060

A simple payback analysis for conversion to natural gas at Fort Hunter-Liggett with savings for operation and maintenance expenses follows:

Estimated Constr. Cost	=	Distr. [1] (FHL)Piping System	+ (FHL) Share of Pipe Main to Fort from Rte 101
Estimated Constr. Cost	=	$3.0 Million	+ $2.3 Million = $5.3 Million
Payback Years	=	Installation Cost / Annual Savings	$5,300,000 / = $ 87,060 = 60.9 YRS

A 60.9 year payback does not make the conversion to natural gas viable.

[1] Refer to Table 5-2 for a detailed cost estimate.

TABLE 5-2

DETAILED COST ESTIMATE FOR NEW NATURAL GAS SERVICE

1	Install utility pipe line from U.S. Hwy 101 to Jolon (PG&E est. 1989) 20 miles	$1,600,000
2	Install utility pipe line from Jolon to FHL (PG&E est. 1989) 7 miles	$1,000,000
	Subtotal	$2,600,000
	Since 1989 estimated $100,000 increase per year	+ $400,000
	Total Cost of pipe line to FHL (1993) =	$3,000,000

ESTIMATE FOR FHL PIPING DISTRIBUTION GRID

1	Utility Pipe Installation (Various Sizes)	60,000 LF	$25	$1,500,000
2	Utility Pipe Fittings (40% of pipe)	1 LS	$600,000	$600,000
3	Excavate/Backfill/Compact Trench	6000 LF	$3	$180,000
4	Repave and Repair Asphalt	1 LS	$100,000	$100,000
5	Repave and Repair Concrete	1 LS	$50,000	$50,000
6	Gas Meters w/PRV	150 EA	$500	$75,000
7	Shut Off Valves at Meters	300 EA	$100	$30,000
8	Branch Isolation Valves	50 EA	$250	$12,500
	Subtotal			$2,547,500
	15 % Contingency for Site Coordination			$ 382,125
	TOTAL			$2,929,625

6.0 FEASIBILITY OF NEW CENTRAL PROPANE PLANT

Propane is the primary fuel used at Fort Hunter-Liggett. There are six (6) buried fuel oil tanks in one clustered area. These tanks are scheduled for replacement and serve the individual buildings 205, 206, 207, 208, 229 and 230.

There are an additional 70 propane tanks presently installed at the Fort that are the property of the Northern Energy Company. These tanks are not piped into any central distribution system, but are located to source feed specific buildings or residences. The existing propane piping systems are sized to provide only the required fuel input in BTUH to the fuel burning equipment, based on distances from an individual propane tank to source of ignition.

The installation of a central propane plant would require the removal of these individual tanks which FHL does not own or provide maintenance for. All the equipment in a central plant would be purchased, owned and maintained by FHL. In addition, a central buried propane piping system grid would be required and would be routed throughout the Fort Hunter-Liggett property.

The estimated cost of the propane distribution piping is $2.75 million dollars, almost as much as the natural gas service reviewed in Section 5.0 of this study. A central propane plant would require a large designated fenced area; and the process equipment and tanks are estimated to cost .75 million dollars. Refer to Table 6-1 for a breakdown of the cost estimate.

A total investment of 3.5 million dollars by the Department of Defense and additional annual maintenance costs would provide FHL with propane fuel at an estimated reduced cost per gallon of $.10 to $.20 from the present delivered price of $.96 per gallon.

The total estimated fuel use per year based on 21,451 x 10^6 BTU/YR at 95,000 BTU/Gallon for propane is 234,181 gallons total. Current propane costs are $.96/Gallon yielding an annual cost of $224,814. At $.76/Gallon the savings would be $46,836 per year.

The simple payback analysis for a central propane plant would be as follows:

$$\text{Payback Years} = \frac{\text{Central Plant Cost}}{\text{Annual Savings}} = \frac{\$3{,}500{,}000}{\$\ 46{,}836} = 74.7 \text{ YRS}$$

The feasibility of a new central propane plant is not a viable consideration for Fort Hunter-Liggett based on a payback of 74.7 years.

TABLE 6-1

DETAILED COST ESTIMATE FOR NEW CENTRAL PROPANE FACILITY

1	Sitework Earthwork Development	$100,000
2	Site Utilities and Lighting	$ 45,000
3	Site Road and Asphalt Work	$ 70,000
4	Site Concrete Work	$ 60,000
5	Propane Storage Tanks	$150,000
6	Propane Unloading Station	$ 80,000
7	Site Fencing and Gates	$ 90,000
8	Site Alarms	$ 35,000
9	Propane Piping Within Fenced Facility	$ 50,000
	Subtotal	$680,000
	10% Contingency For Unknowns	$ 68,000
	Total Cost For Fenced Facility	$748,000
	Rounded up to:	$750,000

1	Utility Pipe Installation (Various Sizes)	55,000 LF	$ 25	$1,375,000
2	Utility Pipe Fitting (40% of Pipe)	1 LS	$550,000	$ 550,000
3	Excavate/Backfill/Compact Trench	55,000 LF	$ 3	$ 165,000
4	Repave and Repair Asphalt	1 LS	$ 90,000	$ 90,000
5	Repave and Repair Concrete	1 LS	$ 45,000	$ 45,000
6	Gas Meters w/PRV	150 EA	$ 500	$ 75,000
7	Shut Valves at Meters	300 EA	$ 100	$ 30,000
8	Branch Isolation Valves	50 EA	$ 250	$ 12,500
	Subtotal			$2,342,500
				$ 351,375
				$2,693,875
			Rounded up to:	**$2,750,000**

7.0 BASE-WIDE METERING PLAN

Metering energy consumption will not in itself save energy, but will assist the Directorate of Engineering and Housing in tracking building energy consumption and in identifying areas of waste. Present and proposed additional metering is addressed below.

7.1 Present Metering Plan

Present electrical service and PG&E metering locations are addressed in Section 3. Electric metering is performed only at the points of service to the installation. PG&E meters electrical consumption separately for only a few remote buildings. Several newer buildings listed below have had watthour meters installed; but no readings are taken.

- Base Exchange, Building 80
- Snack Bar, Building 209
- Clinic, Building 210
- Gymnasium, Building 212
- Motor Pool, Building 252
- Motor Pool, Building 256
- Motor Pool, Building 259
- Family Housing, Building T6
- Family Housing, Building T376

Fuel Oil deliveries to building tanks are recorded on a per trip basis; no individual building delivery records are available. Propane is provided by a commercial supplier. Delivery tickets are available for each tank serviced. Several propane tanks serve more than one building.

7.2 Proposed Metering Plan.

To provide energy usage data for facility energy management, it is recommended that meters be installed at the following buildings. Metering costs are based on estimates provided with Table 7-1.

Single Phase Watthour Meters

P 41A Family Housing NCO & Enl
P 41B Family Housing NCO & Enl
P 42A Family Housing NCO & Enl
P 42B Family Housing NCO & Enl
P 43A Family Housing NCO & Enl
P 43B Family Housing NCO & Enl

Single Phase Watthour Meters (continued)

P 44A	Family Housing NCO & Enl
P 44B	Family Housing NCO & Enl
P 45A	Family Housing NCO & Enl
P 45B	Family Housing NCO & Enl
P 46	Family Housing CG & WO
P 47	Family Housing CG & WO
P 51A	Family Housing NCO & Enl
P 51B	Family Housing NCO & Enl
P 52A	Family Housing NCO & Enl
P 52B	Family Housing NCO & Enl
P 53	Family Housing CG & WO
P 54	Family Housing CG & WO
P 55	Family Housing CG & WO
P 56	Family Housing CG & WO
P 57	Family Housing CG & WO
P 58	Family Housing CG & WO
P 59	Family Housing CG & WO
P 60	Family Housing CG & WO
S 79	Post Office, Main
T 124	Family Housing LC & MJ
T 127	Officers Quarters Military
T 131	Family Housing CG & WO
T 149	Family Housing NCO & Enl
T 161	Admin General Purpose
T 162	Elec Maint. Shop
T 163	Officers Quarters Military
T 164	Admin General Purpose
T 165	Admin General Purpose
T 166	Officers Quarters Military
T 167	Officers Quarters Military
S 198	General Inst Bldg
P 642	Detached Latrine/Shower

Total Watthour Meters: 38 x $3,857 = $146,566

Small 3 Phase Watthour Meters

P 81	Theater with Dressing Rm's
P 101	Hacienda, 3 meters
P 116	Exchange Service Station
T 120	Fire Station
T 121	Bowling Center

Small 3 Phase Watthour Meters (continued)

P 128 Officers Quarters Military
S 146 FE Facility
T 156 FE Facility
T 172 Cold Storage Warehouse
P 177 Technical Library
P 178 Child Development Cntr
S 182 Commissary
P 190 Post Chapel
S 235 Admin General Purpose
S 236 Admin General Purpose
S 237 Admin General Purpose
P 240 Admin General Purpose
S 243 Admin General Purpose
S 244 Admin General Purpose
S 246 Admin General Purpose
S 247 Admin General Purpose
S 286 Admin General Purpose
P 287 Recreation Building
S 288 General Purpose Warehouse

Total Watthour Meters: 24 x $7,381 = $177,144

Large 3 Phase Watthour Meters

S 197 Admin Bldg R&D
P 205 Admin General Purpose
P 206 Enlisted Pers Dining Fac
P 207 Enl Barracks w/o Dining
P 208 Enl Barracks w/o Dining
P 229 Enl Barracks w/o Dining
P 230 Enl Barracks w/o Dining
S 238 Sig Photo Lab
S 241 GM Facility
S 290 Electron Equip Facility
S 291 Cont Humid Warehouse
P 295 Enl Barracks w/o Dining
P 301 ADP Building

Total Watthour Meters: 13 x $8,522 = $110,786

Grand Total Wattmeter Construction Cost = $434,496

7.3 Energy and Cost Savings.

While metering of electric power use does not save energy directly, the DEH will be able to monitor consumption and identify problem areas. Additionally, a program to induce building occupants to save energy could be implemented. Posting reading from meters has been shown to promote competition between building tenants to see who can save the most energy. A vigorous program could produce as much as a 2% to 5% reduction in electricity use, even though tenants are not billed directly.

7.3.1 Potential Energy Savings

Assume 5% saving from baseline electricity use:

• Space Heating and Cooling	411,758 kWH/Yr
• Domestic Hot Water	169,376 kWH/Yr
• Interior Lighting	1,839,150 kWH/Yr
Total	2,420,284 kWH/Yr

Savings = 121,014 kWH/Yr

7.3.2 Energy and Operating Cost Savings

Energy Cost Savings: 121,014 kWH/Yr x $0.06223/kWH = $7,531/Yr

Additional Operating Costs:

Additional operating costs will be incurred to pay a meter reader and to extend the mission of the post energy officer to conduct incentive programs. The potential annual energy cost savings shown above are insufficient to support these additional efforts.

Table 7-1: Metering Plan Unit Cost Estimates

CONSTRUCTION COST ESTIMATE					Date Prepared: February 1993		Sheet: OF
Project: EEAP Limited Energy Study					Project No.: 16-403-10		Basis for Estimate: Code A (no design competed)
Location: Fort Hunter-Liggett, California							
Engineer-Architect: Keller & Gannon							
Drawing No.: Basewide Metering Plan			Estimator: RJB		Checked By: BIH		
Line Item	Quantity No. Units	Quantity Unit Meas.	Labor Per Unit	Labor Total	Material Per Unit	Material Total	Total Cost
WATTMETER FOR LARGE 3 PHASE SERVICES							
Wattmeter	1	Ea	$323	$323	$2,020	$2,020	$2,343
3 Current Transformers	1	Ea	$207	$207	$1,862	$1,862	$2,069
3 Potential Transformers	1	Ea	$33	$33	$645	$645	$677
NEMA 3R Enclosure	1	Ea	$145	$145	$271	$271	$415
Misc. Conduit & Fittings	-	Job	-	$100	-	$50	$54
Subtotal for Large 3 Phase Services							$5,558
Sales Tax 8%							$445
Contractor O.H. & P 30%							$1,668
Sub Total							$7,671
Bond 1%							$77
Sub Total							$7,747
Estimating Contingency 10%							$775
Total Probable Construction Cost Large 3 Phase Services							$8,522
WATTMETER FOR SMALLER 3 PHASE SERVICES							
Wattmeter	1	Ea	$323	$323	$2,020	$2,020	$2,343
3 Current Transformers	1	Ea	$135	$135	$1,002	$1,002	$1,137
3 Potential Transformers	1	Ea	$33	$33	$645	$645	$677
NEMA 3R Enclosure	1	Ea	$192	$192	$411	$411	$602
Misc. Conduit & Fittings	-	Job	-	$125	-	$75	$54
Subtotal for Smaller 3 Phase Services							$4,814
Sales Tax 8%							$385
Contractor O.H. & P 30%							$1,444
Sub Total							$6,643
Bond 1%							$66
Sub Total							$6,710
Estimating Contingency 10%							$671
Total Probable Construction Cost Smaller 3 Phase Services							$7,381
WATTMETER FOR SINGLE PHASE SERVICES							
Wattmeter	1	Ea	$323	$323	$2,020	$2,020	$2,343
NEMA 3R Enclosure	1	Ea	$45	$45	$28	$28	$73
Misc. Conduit & Fittings	-	Job	-	$75	-	$25	$100
Subtotal for Large 3 Phase Services							$2,516
Sales Tax 8%							$201
Contractor O.H. & P 30%							$755
Sub Total							$3,472
Bond 1%							$35
Sub Total							$3,507
Estimating Contingency 10%							$351
Total Probable Construction Cost Large 3 Phase Services							$3,857

8.0 FEASIBILITY OF BASE-WIDE FM RADIO ENERGY MONITORING AND CONTROL SYSTEM

A general feasibility review for application of an FM Radio Energy Monitoring and Control System (EMCS) at Fort Hunter-Liggett is summarized in this section. The feasibility analysis was performed using guidance and criteria provided in TM 5-815-2, "Energy Monitoring and Control Systems."

The following paragraphs summarize the analysis that led to the recommendation that a Base-wide EMCS not be implemented at Fort Hunter-Liggett. Refer to Appendix D for backup data and calculations.

8.1 Potential Systems For Connection To EMCS By Program Function

The following list identified EMCS program functions that were considered in the analysis together with the applicable equipment:

- Scheduled Start-Stop/Duty Cycling/Demand Limiting
  - Single-zone air-handling units
  - Single-zone DX air-handling units
  - Heating and ventilating units
  - Electric unit heaters
  - Air-cooled chillers
  - Air-cooled DX compressors
  - Electric domestic hot water heaters
  - Heat pumps
- Optimum Start-Stop
  - Single-zone air-handling units
  - Single-zone DX air-handling units
  - Heating and ventilating units
  - Electric unit heaters
  - Air-cooled chillers
  - Air-cooled DX compressors
- Day/Night Temperature Setback
  - Single-zone air-handling units
  - Single-zone DX air-handling units
  - Heating and ventilating units
  - Hot water unit heaters
  - Air-cooled chillers

- Economizer/Ventilator/Recirculation
  - Single-zone air-handling units
  - Single-zone DX air-handling units
  - Heating and ventilating units
- Chilled Water Temperature Reset
  - Air-cooled chillers
- Condenser Water Temperature Reset
  - Water-cooled chillers
- Hot-Water Outside Air Temperature Reset
  - Hot water boilers
- Boiler Plant Monitoring
  - Hot water boilers
- Summer/Winter Changeover
  - Heating and cooling plants

8.2 Local Building Retrofits Included In EMCS Analysis

The following control functions, included in cost-effective local building retrofits, are included in the EMCS analysis. Energy savings computed for the following ECO's are used in the EMCS analysis:

- Install load shedding system (ECO B1)
- Install outside air temperature reset (ECO B5)
- Install time clocks (ECO B6)
- Provide night setback/setup (ECO B7)
- Install economizer controls (ECO B11)
- Automate summer/winter switchover (ECO B16)

- Install outside air temperature reset (ECO B5)

- Install time clocks (ECO B6)
- Provide night setback/setup (ECO B7)
- Install economizer controls (ECO B11)
- Automate summer/winter switchover (ECO B16)

8.3 Description Of Potential EMCS

Applying the control functions described above to Fort Hunter Liggett facilities yields a system of approximately 1,130 monitoring and control points. The supervisory control center would consist of a standard PC, alarm printer, logging printer, and a cartridge tape system for historical data storage. Remote terminal units would be installed in the mechanical equipment room of each interfaced facility. The data transmission system connecting the supervisory control center to the remote units would be a two-way FM radio system. The remote transceivers could be an integral component of the remote terminal units.

The proposed system includes 45 significant facilities on the post, and does not include any personnel housing.

8.4 Life-Cycle Cost Analysis

The estimated construction cost of implementing the EMCS as described in paragraph 8.3, which includes 45 significant buildings on the post is $2.34 million. When the operating and maintenance costs of the system are considered, an annual cash flow results, as shown below:

Annual electricity consumption savings	$40,207
Annual electricity demand savings	12,128
Annual fuel oil savings	12,251
Annual propane savings	26,750
Annual manpower savings	52,800
Less: EMCS operation and maintenance costs	(58,000)
Net annual savings	$86,136

9.0 FEASIBILITY OF COGENERATION

With a main PG&E utility system and grid in place, cogeneration of electric power at Fort Hunter-Liggett is not feasible as a new sole source supply. However, a review of the fuel oil conversion at Buildings 205, 207, 208, 229, 230 and conversion of Dining Hall 206 to an all electric kitchen was considered as a combination project, but the results indicate that such a project is not economically feasible.

A cogeneration plant would consist of two propane fired 500 kW generators with heat recovery to serve these buildings. Construction of this plant would eliminate the requirement for six new underground double wall fuel oil storage tanks (UST) and permit removal of/abandoning the existing boilers in Buildings 205, 207, 208, 229 and 230. A high temperature central heat recovery loop would be piped from the cogeneration plant to all six buildings and a heat exchanger with secondary pump would be installed in each building's Mechanical Room to replace the oil fired boiler. The existing heating system pumps and distribution system for heating coils and domestic hot water would be modified, connected to the new heat exchangers and reused. The propane retrofit of two boilers in Building 206 would serve the remaining heating load.

There would be no need to install six new double wall UST's with monitoring systems and sensors for fuel oil storage and concerns regarding pollution problems associated with these oil fired boilers would be eliminated. In addition the generated energy produced would be optimized with heat recovery from the engine jacket and the flue.

The Fort Hunter-Liggett annual electric demand for the last three fiscal years has been above the 1,000 kW component that would be generated, allowing the equipment to be operated at peak efficiency year round and paralleled with the PG&E utility grid. This arrangement would create a thermal load profile of a 1,000 kW "base" electric load at a fuel-to-power efficiency above 90 percent and would allow Fort Hunter-Liggett to continue to purchase the remaining balance from PG&E. Total energy usage at Fort Hunter-Liggett would be reduced by the more efficient operation of a cogeneration plant which would provide both power and thermal energy. A comparison between PG&E rates for annual 24 hour usage and demand charges with the price of propane and generation usage follows, together with a cost estimate for the cogeneration plant and associated components located in the buildings.

Based on the following calculations, annual savings from cogenerating electrical power with heat recovery is only $5,282 per year compared with current PG&E power costs and the cost of heating water with oil fired boilers. The use of cogeneration is not a feasible option at Fort Hunter-Liggett, with a simple payback of 162.8 years.

A. Detailed payback analysis for providing 1,000 kW of generated power by cogeneration with heat recovery using propane versus existing PG&E power with fuel oil boilers for heat and hot water is as follows:

1) The propane generators operate at 128 GPH to produce 1,000 kW of power and 6,053,333 BTUH of hot water at 195°F and the flue insert coils will provide an additional 2,000,000 BTUH. The operation will be continuous all year and the bulk rate user price for propane is $.76 per gallon. Therefore, 128 gallons x 24 hours x 365 days would be 1,121,280 gallons usage x $.76 for an annual cost of $852,173.

2) The operation and maintenance for this system is estimated at $6,000 per year.

3) The current PG&E year round rate for 24 hour operation per kWH is $.06223. Multiplying 1,000 kW x 24 hours x 365 days will be 8,760,000 kWH annual usage times $.06223 gives and annual cost of $545,135.

4) The PG&E demand rate for 24 hour operation is $108.60 per kW per year gives an annual cost of $108,600.

5) The present fuel oil system for heat and hot water uses 288,000 gallons per year times a rate of $.69 per gallon which gives a cost of $198,720.

6) The operation and maintenance for this system is currently $11,000 per year.

The estimated annual cost savings by using a cogeneration system would be the difference between items 1 and 2 and items 3, 4, 5 and 6 as noted below.

($852,173 + $6000) - ($545,135 + $108,600 + $198,720 + $11,000)

which gives an estimated annual savings of $5282 per year.

A simple payback analysis would be as follows:

Estimated cogeneration installed cost[1] - Minus, estimated savings for fuel oil tank system not installed or $985,000 - $125,000 = $860,000

$860,000 cost ÷ $5282 annual savings = 162.8 years

This payback period is not reasonable for consideration.

[1] See Table 9-1 for a breakdown of installed cost.

TABLE 9-1

DETAILED COST ESTIMATE FOR PROPANE COGENERATION PLANT ON SITE AT FORT Hunter-Liggett

1.	Propane conversion of boilers at Building 206 and secondary boiler pumps	=	$ 24,486
2.	Exterior heat recovery distribution system piping	=	$176,761
3.	Heat exchanger, pump and modifications to Mechanical Room Building 206	=	$ 63,973
4.	Heat exchanger, pump and modifications to Mechanical Room Building 205	=	$ 15,570
5.	Heat exchanger, pump and modifications to Mechanical Room Building 207	=	$ 15,570
6.	Heat exchanger, pump and modifications to Mechanical Room Building 208	=	$ 15,570
7.	Heat exchanger, pump and modifications to Mechanical Room Building 229	=	$ 15,570
8.	Heat exchanger, pump and modifications to Mechanical Room Building 230	=	$ 15,570
9.	Heat recovery main loop pumps (2)	=	$ 8,000
10.	Heat recovery flue insert coil type (2)	=	$ 4,600
11.	Propane fired generator sets with heat recovery jackets (1,000 kW)	=	$500,000
	Subtotal		$855,670
	15% contingency for site coordination		128,350
			$984,020
		Rounded up to:	**$985,000**

A. The propane storage tanks will be provided and maintained by supplier. (- $0.00)

B. Not installing six new UST's with double containment piping, leak detection and alarms. (- $125,000)

10.0 ALTERNATIVE IMPLEMENTATION METHODS

In April 1986, Congress passed a law (42 USC 8287) which gave federal agencies the authority to enter into long-term (up to 25 years) contracts for Shared Energy Savings (SES) services. The SES law permits government acquisition of facility improvements that reduce energy consumption which are financed by private funding. The contractor's investment is recouped through a share of the savings that result directly from the contractor-installed energy savings measures. The SES contract must include a method for establishing the baseline energy use and cost as well as a method for measuring the savings achieved by the energy reduction measures.

In order to interest SES contractors, in general, the value of the construction contract for energy savings measures must exceed $1,000,000 and the simple payback must be three years or less. The set of project recommendations for Fort Hunter-Liggett developed in this study does not meet these minimum criteria.

11.0 IMPACT OF CHANGING TO ENVIRONMENTALLY ACCEPTABLE REFRIGERANTS

The Clean Air Act (CAA) which went into effect on July 1, 1992 states in Section 608 "It shall be unlawful for any person in the course of maintaining, servicing, repairing or disposing of an appliance or industrial process refrigeration, to knowingly vent or otherwise knowingly release or dispose of any Class I or Class II substance used as a refrigerant in such appliance (or industrial process refrigeration) in a manner which permits such substance to enter the environment." The purpose of this Act is to eliminate the refrigerants with the most global warming potential (GWP) and to protect the stratospheric ozone layer.

A violation of this section of the CAA carries a penalty of $25,000.00 per day and it is possible that the Environmental Protection Agency (EPA) may offer bounties for information on violators.

The existing chloroflurorocarbons (CFC) that are the most common refrigerants are CFC-11 and 12 and also R-113, 114 and 500 (which contains R-12). There is no "quick-fix" for the environment and there is no "instant replacement refrigerant" available at the present time, that will solve all problems, be environmentally safe and still be cost effective. There will be an end to production of CFC's by 1996 and the transition of replacement refrigerants into existing equipment must be planned and implemented today.

The transition plan must include: recovery and containment of CFC's; equipment phaseout evaluation based on age, size, location, refrigerant type, conversion applicability, projected future equipment types and applicability advice from manufacturer. There should be planned review of refrigerants being tested presently by the Air-Conditioning and Refrigeration Institute (ARI) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) latest standards. ASHRAE Standard 15 ("Safety Code for Mechanical Refrigeration") and Standard 34 ("Number Designation and Safety Classification of Refrigerants") were updated in 1992.

There have been successful refrigerant replacement projects using Halocarbon refrigerants HCFC-123 in place of CFC-11 and HFC-134a in place of CFC-12. These newer refrigerants use polyester oil for lubrication.

The HCFC-123 refrigerant has 98% less ozone-depletion potential, less global warming impact and shorter atmospheric lifetime than CFC-11. These conversions reused the existing chiller equipment with changes in gaskets, seals and transducers. In addition, new purge vent lines were necessary and upgraded installation HCFC alarms and sensors were provided. The CFC-11 refrigerant was recovered from the equipment prior to the refurbishment and a new supply of HCFC-123 was charged into the unit and tested for leaks. Refrigerant recovery equipment is available for purchase or rent to be used by maintenance staff. Alternatively, there are recovery contractors that can be hired. The life expectancy of existing equipment will not exceed the availability of HCFC-123 which is produced until year 2030. The newest alternate

(HFC) refrigerant R-245ca is in the preliminary testing phases at the present time, but the preliminary comparisons of thermophysical properties and performances are very close to R-11 and R-123.

The HFC-134a refrigerant has a zero ozone-depletion potential (ODP) and is presently being used in new manufactured chillers. The use of either HCFC-123 or HFC-134a as a replacement refrigerant requires recalculation of equipment cooling capacity due to its lower theoretical efficiency which will de-rate existing equipment. A reduction in chiller capacity of 10 to 25 percent on some equipment will seriously effect the comfort level or process load of the application. The choice of installed equipment does not usually allow for that large an oversizing in capacity, and the lower equipment efficiency will require 4% to 10% additional energy to be used.

The manufacturing of HFC-134a is a two-step process which means the cost of production is higher, thus making it the most expensive HCFC.

HCFC-22 at 5% ODP and HCFC-123 at 2% ODP are also scheduled for future phaseout and HFC-134a is the present refrigerant alternative. A short term solution presently available for replacement of HCFC-502 is using HCFC-22 with the eventual replacement being HFC-134a, or future refrigerants blends, which are under development.

The existing process refrigeration equipment on Fort Hunter-Liggett is located in Buildings 80 (Post Exchange), 182 (Commissary), 172 (Cold Storage) and 241. The refrigerant R-22 is used in 4 Hussman Model HOCA0313VHKXU units located in Building 182 and were the only units noted in the field survey with an HCFC refrigerant. This refrigerant will be applicable for use until 2020. All other process refrigeration equipment surveyed used R-12 and 502 and these refrigerants will no longer be produced after 1996.

This existing equipment can possibly be retrofitted with HCFC-22 components and be recharged and utilized until year 2020, and there are new Dupont replacement refrigerants MP-39(R-12) and MB-80(R-502) that are being tested at the present time and could possibly be available in the Fall of 1993.

Refurbishment of the existing equipment can be divided into three possible categories:

1) Small units (requiring less than 1000 lb charge): Post Maintenance Mechanical staff could do all or portions of this work.

2) Large units (requiring more than 1000 lb charge): This work should be performed by an outside refrigeration contractor.

3) Obsolete units (those units too old to be refurbished): This work should be an engineered design for replacement type systems and equipment. The construction documents could be bid and the units contractor installed. The choice of refrigerant

and type of equipment would be an engineering decision based on the most efficient and longest life system available at the time.

The existing HVAC equipment installed at Fort Hunter-Liggett consists of roof mounted, pad mounted and split systems. The field survey of this equipment noted that R-22 refrigerant was the charge used. This type of HVAC equipment has an estimated mechanical life of twenty years and the availability and production of R-22 refrigerant is presently scheduled to the year 2020.

Therefore, this existing equipment should not be affected by either the EPA regulations or the U.S. Clean Air Act for the next 26 years. During this time period, as equipment life expires, it is recommended that all replacement HVAC equipment be chosen that uses one of the newer refrigerant types. All new refrigerants will be provided with an ODP (Ozone Depletion Potential) rating, equal to HFC-134a, which has a zero ODP rating. The R-22 refrigerant (HCFC-22) is a hydrochlorofluorocarbon and has a 5% ODP rating.

Any existing HVAC equipment at Fort Hunter-Liggett still in operation in the year 2019 that is charged with R-22 refrigerant shall be scheduled for replacement to bring Fort Hunter-Liggett in compliance with the U. S. Clean Air Act and EPA regulations prior to January 1, 2020.

A summary of the Montreal Protocol refrigerant production caps for CFC's and HCFC's is provided in Table 11-1.

Short-term and long-term solutions for existing CFC and HCFC refrigerants used in various process refrigeration and air conditioning system types are summarized in Table 11-2.

TABLE 11-1

REFRIGERANT PRODUCTION TABLE

(Montreal Protocol Production Caps)

CFCs	**1 January**	
	1993	50% of 1986 production level
	1994	25%
	1995	25%
	1996	0%
HCFCs	Production caps begin January 1 1996, based on 3.1% of CFCs used in 1989 *weighted by ozone depletion potential* (ODP); **plus** ODP-weighted 1989 HCFC consumption...thus:	
	1 January	
	1996	Cap (Above formula)
	2004	65% of cap
	2010	35% of cap
	2015	10% of cap
	2020	0.5% of cap
	2030	0.0% - Total Phaseout

TABLE 11-2

SHORT-TERM AND LONG-TERM REFRIGERANT SOLUTIONS

System Type	Refrigerant		
	Existing	Short-Term Solution	Long-Term Solution
Chillers	CFC-11[1],113	HCFC-123	HCFC-123[2]
	CFC-12, R-500	HFC-134a	HFC-134a
	CFC-114	HCFC-124	HCFC-124
	HCFC-22[2]	HCFC-22[2]	HFC-134a
Refrigerators/Freezers	CFC-12	HFC-134a	HFC-134a
Mobile Air Conditioners	CFC-12	HFC-134a	HFC-134a
Transport Refrigeration	CFC-12	HFC-134a	HFC-134a
Commercial Refrigeration			
- High and Medium Temperature	CFC-12[1]	HFC-134a	HFC-134a
- Low Temperature	HCFC-502[2]	HCFC-22[2]	HFC-134a
Industrial Refrigeration	CFC-502[1]	HFC-134a	HFC-134a
Residential Air Conditioning and Heat Pumps	HCFC-22[2]	HCFC-22[2]	HFC-134a

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[1] After 1996, 0 production per Montreal Protocol Table 11-1

[2] After 2030, 0 production per Montreal Protocol Table 11-1, but by 2020 the production of .5% will make it very expense to use and HFC-245ca is only in the preliminary test stage at the present time.

APPENDIX A

Scope of Work and Minutes of Project Meetings

CESAM-EN-CC

November 1991

GENERAL SCOPE OF WORK

FOR A

LIMITED ENERGY STUDY

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Review the previously completed studies related existing fuels or electrical power use and or fuel conversion proposals.

1.2 Perform a limited site survey of specific buildings,sytems or areas to collect all data required to evaluate the specific ECOs included in this study.

1.3 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.4 Provide project documentation for recommended ECOs as detailed herein.

1.5 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. GENERAL

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from CEHSC-FU, dated 28 June 1991 and the latest revision from CEHSC-FU establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to determine the energy savings of ECOs which would replace or significantly change an existing heating, ventilating, and air-conditioning (HVAC) system. The rquirement to use computer modeling applies only to heated and

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interview at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition these projects shall have the necessary documentation prepared, as required by the Government's representative, for one of the following categories:

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost greater than $3,000 but less than $100,000 and a simple payback period of two years or less.

b. Productivity Enhancing Capital Investment Program (PE-CIP). This program is for projects which have a total cost of greater than $3,000 but lees than $100,000 and a simple payback period of four years or less.

c. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than $100,000 and a simple payback period of four years or less.

The above programs and the required documentation forms are all described in detail in AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than $200,000 and a simple payback period of four to twenty-five years.

Documentation shall consist of DD Form 1391 and a Project Development Brochure.

e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing (DEH) can perform using his resources. Documentation shall be as required by the DEH.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Review Previous Studies. Review the previous studies or proposals listed in Annex A. This review should acquaint the AE with the work that has been performed previously. Some infomation the AE may need may be contained in these studies or proposals.

7.2 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.4.2 The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Engineering and Housing to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.4.3 Prefinal Submittal. The AE shall prepare and submit the prefinal report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph 7.4.1 shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The prefinal report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

CESPK-ED-M (415-10f) 18 August 1992

THE DETAILED SCOPE OF WORK

SUBJECT: Energy Engineering Analysis Program (EEAP), FY92.

CONTRACT NO. DACA05- 92-C-0155

A-E ADDRESS: Keller and Gannon
1453 mission Steet
San Francisco, California

POINT OF CONTACT: Messrs. Richard Lennig/Blair Horst

PHONE NO: (415) 621-1199

1. Project Data:

1.1 Installation and Location: Fort Hunter Liggett, California

1.2 Study Title: Limited Energy Study.

1.3 Project No. 102

1.4 Authorization: CEMP-ET (1110) Memorandum dated 18 Nov 91, Subject: Energy Engineering analysis Program (EEAP) - FY92 Program.

2. Project Description/Services:

a. Limited Energy Study (LES): The work and services for this project require a limited basewide energy survey and evaluation of Fort Hunter-Liggett's buildings, systems operation, and fuel supply and resources. The General Scope of Work (GSOW) (enclosure 1) describes and specifies the general requirements and procedures for conducting the study, documenting study finding and, preparation of study report.

b. This Detailed Scope of Work (DSOW) supplements the GSOW by identifying specific projects, systems and areas to be investigated for the study in accordance with Fort Hunter-Liggett facility engineers (DEH) requirements and needs. Should there be a conflict between the GSOW and the DSOW, the DSOW shall govern.

3. Related Projects and Studies:

3.1 Annex D lists proposed construction projects identified for Fort Hunter-Liggett. The current status of each project is indicated. The A-E shall indicate in the study the impact of each project will have on the installation's energy use/consumption and energy reduction goals.

3.2 Reevaluate PGE feasibility study of extending natural gas service to Fort Hunter-Liggett, 1989. The reevaluation shall include

6.4 A preinterim conference will be held at the installation upon the completion of the field investigation and energy audit. The preinterim conference will be held to review the information obtained during the field investigation and obtain guidance for organizing and determining content for the interim report submittal.

6.5 Point of contact during the study is as noted below

a. Ft Ord DEH: Richard Ducoing, (408) 242-2051, DEH Energy Coordinator

b. Ft Hunter-Liggett DEH, Mark Grandstaff, (408) 408 385-2514, FE

c. A-E: Mssers. Richard Lennig and Blair Horst (415) 621-1199, Keller and Gannon

d. Sacramento District: Nathaniel Hunter, Intallation Support Section, (916) 557-7413

6.6 Copies and distribution of submittals shall be as specified herein below:

a. HQ FORSCOM, ATTN: FCEN-RDF, Mr Naresh Kapur, Fort McPherson, Georgia 30330-6000, one (1) copy.

b. Corps of Engineers, Mobile District, ATTN: CESAM-EN-CC (Mr. Tony Battaglia), P.O. Box 2288, Mobile, Alabama 36628-0001 one (1) copy.

c. Cdr. Fort Ord & 7th Inf. Div (light), ATTN: AFCW-DE (Mr. Richard Decoing, Fort Ord, California 93941-5777, six (6) copies

d. Fort Hunter-Liggett FE, C/O Fort Ord & 7th Inf. Div, AFCW-DE, ATTN: Mr. Mark Grindstaff, Fort Ord, California 93941-5777, three (3) copies.

e. Corps of Engineers, Sacramento District, ATTN CESPK-ED-M (N. Hunter), 1325 J Street, Sacramento, California 95814-2922, four (4) copies.

7. Government Furnished documentrs:

(1) ETLs 1110-3-254, Use of Electric Power for Comfort Space Heating (if applicable), 1110-3-282, Energy Conservation, and 1110-3-332, Economic Studies.

(2) Architectural and Engineering Instructions/Design Guide Criteria dated 14 June 89.

(3) Energy Conservation Investment Program (ECIP) Guidance, dated 28 June 1991 and the latest revision with current energy prices and discount factors for life cycle cost analysis.

(4) TM 5-785, Engineering Weather Data, TM 5-800-2, General Criteria Preparation of Cost Estimates.

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.
   - o Total Annual Energy Used.
   - o Source Energy Consumption.

     Electricity - KWH, Dollars, BTU Fuel Oil - GALS, Dollars, BTU Natural Gas - THERMS, Dollars, BTU Propane - GALS, Dollars, BTU Other - QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.
   - o ECOs Investigated.
   - o ECOs Recommended.
   - o ECOs Rejected. (Provide economics or reasons)
   - o ECIP Projects Developed. (Provide list)*
   - o Non-ECIP Projects Developed. (Provide list)*
   - o Operational or Policy Change Recommendations.

   * Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.
   - o Total Potential Energy and Cost Savings.
   - o Percentage of Energy Conserved.
   - o Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

ANNEX C

REQUIRED DD FORM 1391 DATA

To facilitate ECIP project approval, the following supplemental data shall be provided:

a. In title block clearly identify projects as "ECIP."

b. Complete description of each item of work to be accomplished including quantity, square footage, etc.

c. A comprehensive list of buildings, zones, or areas including building numbers, square foot floor area, designated temporary or permanent, and usage (administration, patient treatment, etc.).

d. List references, and assumptions, and provide calculations to support dollar and energy savings, and indicate any added costs.

(1) If a specific building, zone, or area is used for sample calculations, identify building, zone or area, category, orientation, square footage, floor area, window and wall area for each exposure.

(2) Identify weather data source.

+

(3) Identify infiltration assumptions before and after improvements.

(4) Include source of expertise and demonstrate savings claimed. Identify any special or critical environmental conditions such as pressure relationships, exhaust or outside air quantities, temperatures, humidity, etc.

e. Claims for boiler efficiency improvements must identify data to support present properly adjusted boiler operation and future expected efficiency. If full replacement of boilers is indicated, explain rejection of alternatives such as replace burners, nonfunctioning controls, etc. Assessment of the complete existing installation is required to make accurate determinations of required retrofit actions.

f. Lighting retrofit projects must identify number and type of fixtures, and wattage of each fixture being deleted and installed. New lighting shall be only of the level to meet current criteria. Lamp changes in existing fixtures is not considered an ECIP type project.

CESPK-ED-M (410-10f) 17 August 1992

ANNEX E

BUILDING LIST

SUBJECT: EEAP, Limited Engery Study, Fort Hunter-Liggett

BUILDING NO.	CAT. CODE	BLDG. DESCRIPTION	SQ FT
*T00006	71115	NCO/ENL HSG	1060
*P00041A	71115	NCO/ENL HSG	1937
P00041B	71115	NCO/ENL HSG	1937
P00042A	71115	NCO/ENL HSG	1937
P00042B	"	" "	1937
P00043A	"	" "	1937
P00043B	"	" "	1937
P00044A	"	" "	1937
P00044B	"	" "	1937
P00045A	"	" "	1937
P00045B	"	" "	1937
*P00046	71114	FAM HSG	2089
P00047	71114	FAM HSG	2089
*P00051A	71115	FAM HSG	1937
P00051B	71115	FAM HSG	1937
P00052A	71115	FAM HSG	1937
P00052B	71115	" "	1937
P00053	71114	" "	2089
*P00054	71114	" "	2089
P00055	71114	" "	2089
P00056	71114	" "	2089
P00057	71114	" "	2089
P00058	71114	" "	2089
P00059	71114	" "	2089
P00060	71114	" "	2089
*P00079	73073	POST OFFICE	1000
*P00080(1)	74053	POST EXCHANGE	9093
*P00081	74076	THEATER W/DRESS RM	6719
*P00101	74046	CONSOLIDATE DINING	22211
T00111	71114	FAM HSG	2112
S00114	72360	DAY ROOM	1015
*P00116	74052	EXCHANGE SERVICE STATION	1788
*T00119	73010	FIRE STATION	4517
*T00120	74077	THEATER W/O DRESS RM	9600
*T00121(1)	74011	BOWLING CENTER	5580
*TOO124	71113	FAM HSG	2033
*T00127	72410	OFFICER QTRS	2250
*T00128(1)	72410	OFFICER QTRS	20196
S00130	44270	GEN STOREHOUSE	287
*T00131	71114	FAM HSG	998

P00208A	14185	CO HQQTRS	5161
*P00209	74062	SNACK BAR	3320
*P00210(1)	55040	DENTAL CLINIC	10973
*P00212	74034	GYNASIUM	8907
P00219	74028	PHYS FIT CTR.	3212
P00228	44220	GEN PURPOSE WHSE	3000
*P00229(1)	72111	ENL BRK W/O DINING	40915
P00230(1)	72111	ENL BRK W/O DINING	35820
P00230A	14185	CO HDQTRS	5161
S00232	44220	GEN PURPOSE WHSE	4075
S00233	44220	GEN PURPOSE	4070
S00235	61050	ADMIN GEN PURPOSE	3000
S00236	61050	ADMIN GEN PURPOSE	3000
S00237	61050	ADMIN GEN PURPOSE	3000
*P00238(1)	14130	SIG PHOTO LAB	14548
S00240	61059	ADMIN GEN PURPOSED	3000
*S00241	31220	GM FAC	10000
S00243	61050	ADMIN GEN PURPOSE	3000
S00244	61050	ADMIN GEN PURPOSE	3000
S00246	61050	ADMIN GEN PURPOSE	3000
S00247	61050	ADMIN GEN PURPOSE	3000
*P00252	21410	VEH MAINT SHOP	12299
P00256	21410	VEH MAINT SHOP	5294
P00257	21470	OIL STORAGE BLDG	360
P00259	21410	VEH MAINT STORAG	13667
S00264	44220	GEN PURPOSE WHSE	4050
S00265	44220	GEN PURPOSE WHSE	3000
*S00283	21910	FE MAINT SHOP	4000
S00286	61050	ADMIN GEN PURPOSE	3000
*P00287	82613	RECREATION BLDG	5584
S00288	44210	GEN PURPOSE WHSE	3000
S00289	44270	GEN STOREHOUSE	4000
SOO290(1)	31740	ELECTRONIC EQIP FAC	14856
*S00291(1)	44230	CONT HUMIDITY WHSE	7400
*P00295(1)	72111	ENL BRK/WO DINER	46593
P00297	61050	ADMIN GEN PURPOSE	3000
P00299	61050	ADMIN GEN PURPOSE	3000
*P00301(1)	61031	ADP BLDG	10800
S00320	44220	GEN PURPOSE WHSE	3000
S00321	61050	ADMIN GEN PURPOSE	3000
*S00325	81110	PWR PL BLDG FOS	1440
S00328	44220	GEN PURPOSE WHSE	4000
T00360	71115	FAM HGS	983
T00376	71114	FAM HGS	2127
P00416	17120	GEN INST BLDG	800
S00488	13160	XMTR BLDG RADIO	1000
T00624	12310	GAS STATION BLDG	192
T00630	72410	OFFICER QTRS	2250
T00640	72410	OFFICE QTRS	1759
*P00642	72324	LATRIN-SHOWER BLDG	995

ANNEX F

GENERAL ENGERY CONSERVATION OPPORTUNITIES

- Insulation (piping, buildings, ducts,etc)
- Glazing
- Caulking
- Solar film
- Reduction of glass area
- Reduce lighting level
- Replace incandescent lighting
- Use more efficient lighting source
- Improve power factor
- High effficient motor
- Economizer cycles
- Nigh setback/setup thermostat
- FM radio control
- Reduce domestic hot water consumption (showers restrictors, etc.)
- Reduce air flow
- Install time clocks
- Improve boiler/chiller controls
- Replace inefficient boilers/chillers
- Upgrade HVAC controls
- Transformer overvoltage
- Transformer loading

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3 August 1992

MINUTES OF MEETING

AT: Fort Hunter-Liggett (FHL), Hacienda

ON: 30 July 1992

SUBJECT: EEAP Limited Energy Study
Fort Hunter-Liggett

THOSE PRESENT:

Name	Affiliation	Telephone No.
Richard F. Ducoing	Energy, DEH Fort Ord	(408) 242-2051
Mark Grindstaff	DEH, FHL	(408) 385-2514
Connie Luallen	PG&E	(408) 755-3499
Tai H. Cao	DEH, MP, Ft. Ord	(408) 242-2741
Rene Dela Fuente	DEH, Fort Ord, EPSD	(408) 242-2134
Naresh Kapur	HQ FORSCOM, Fort McPherson	(404) 669-6731
Nathaniel Hunter	CESPK-EA-M/ISS, Sacramento District	(916) 557-7413
Richard C. Lennig	Keller & Gannon	(415) 621-1199
Blair Horst	Keller & Gannon	(415) 621-1199

1. The purpose of the meeting was to clarify the detailed scope of work for the subject project.

2. Ms. Luallen of PG&E related the results of a 1989 study examining the feasibility of extending a natural gas line to FHL:

   The nearest transmission line is 27 miles away at Highway 101. Estimated cost of a 20 mile line to Jolon was $1.6 million; and the 7 miles into FHL containment area was estimated at $1.0 million more. With only $150k annual revenue estimated from customers in this new service area, the project was dropped from further consideration.

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3. Current average PG&E natural gas and electricity rates are as follows:

   a. Interruptible service to master service point $0.25/therm
   b. Firm service to burners/boilers $0.55/therm
   c. Electricity including demand $0.085/kwh

4. PG&E performed an energy audit at FHL several years ago, but the base did not follow-up on recommendations.

5. Mr. Ducoing, DEH Energy Coordinator at Fort Ord, provided the following project data:

   a. Electrical energy ..... $1,100,00 annually

   b. Fuel oil ..... $275,000 annually (without mobility fuels)

   c. Propane ..... 98,000 annually

   d. Electricity usage is 11% in excess of current goal

6. The most intense energy user at FHL is Texcom. A number of air conditioned Butler-type buildings have been erected on site to support Texcom. These contractors have no incentive to curtail energy usage since they are not metered and billed.

7. It was agreed that detailed scope of work would define this project as a basewide study, since no overall energy study has previously been prepared for FHL. Items to be included in the detailed scope are as follows:

   a. Reevaluate the feasibility of natural gas service to FHL, including an assessment of potential new customers in the surrounding area.

   b. Review, update and incorporate recommendations from PG&E's energy audit.

   c. Survey all buildings for compliance with Army Energy regulations and policy.

   d. Investigate cooling systems with regard to efficient sizing, loads, controls, zoning, etc.

   e. Evaluate individual facility metering as a management tool. Consider potential for additional reimbursable accounts.

f. Evaluate feasibility of a basewide EMCS.

g. Evaluate feasibility of cogeneration (PG&E will pay their avoided costs).

h. Consider shared energy savings, PG&E rebates and third party contracting in the study.

8. Potential funding sources for construction of recommended projects were discussed. Funding is available from FORSCOM for ECIP projects. Projects with 100% non-energy savings now qualify for ECIP funding. OMA funding might be considered at FORSCOM.

9. Action items as a result of the meeting are:

a. Mr. Cao of Fort Ord DEH will prepare an updated building information schedule and site plan within one week.

b. Mr. Hunter of CESPK will incorporate the updated building schedule in a detailed scope of work to be available in 2-3 weeks.

10. The contract must be negotiated by 30 September 1992, since it is funded in the FY92 budget.

11. Mr. Ducoing provided copies of PG&E invoices for FY90, FY91 and FY92 through March.

Richard C. Lennig

16-403-10

cc: Mr. Nathaniel Hunter, CESPK-EA-M/ISS
U.S. Army Engineer District, Sacramento

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20 October 1992

MINUTES OF MEETING

AT: Fort Hunter-Liggett, California

ON: 16 October 1992 13:00 PM

SUBJECT: EEAP Limited Energy Study, Fort Hunter-Liggett, California
Field Investigation Exit Briefing
Contract Number: DACA05-92-C-0155 with the Sacramento Corps. of Engineers

ATTACHMENTS: (1) Facility Engineers Quick-Fix List

THOSE PRESENT:

Name	Affiliation	Telephone No.
Mark Grindstaff	DEH, FHL	(408) 385-2514
Richard C. Lennig	Keller & Gannon	(415) 621-1199
Blair I. Horst	Keller & Gannon	(415) 621-1199
Ronald J. Bush	Keller & Gannon	(415) 621-1199

1. The meeting was held to inform the Facility Engineer of findings from field investigations conducted for the project.

2. Overall, K&G has inspected all facilities listed in Annex E of the Detailed Scope of Work. One building substitution was made and three additional facilities were inspected.

   Building P-46 was inspected in lieu of building P-47; the buildings are identical. Buildings P-211 and P-219 (Heated Swimming Pool and Physical Fitness Center) and Building P-240 (Administration, General Purpose) were also inspected. The Physical Fitness Center and Swimming Pool represent potentially large energy consumers. Building P-240 is identical to numerous office buildings constructed recently.

3. Mr. Horst provided Mr. Grindstaff with a copy of the Facility Engineers Quick-Fix List (Attachment (1)). This list includes minor repair items discovered during field

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investigations. Mr. Horst stated that, overall, mechanical and electrical systems at Fort Hunter-Liggett are operated and maintained better than they are at most other Army facilities he has inspected. This fact is illustrated by the brevity of the Quick-Fix List (usually 6-10 pages for similar sized locations).

4. Mr. Lennig summarized the remainder of the project schedule, stating that the Scope of Work requires delivery of the Interim Submittal 150 calendar days following the Notice to Proceed. Keller & Gannon will coordinate closely with Fort Hunter-Liggett DEH and the Fort Ord Energy Office in the development of energy conservation projects.

Blair I. Horst

Blair I. Horst

16-403-10

cc: Mr. Nathaniel Hunter, CESPK-EA-M/ISS
U.S. Army Engineer District, Sacramento

Richard F. Ducoing, Energy Office, AFZW-DE-R
DEH, Fort Ord, California

Facility Engineer's Quick Fix List -- Fort Hunter Liggett	
Building Number	**Description of Repair Needed**
47	Rebalance air supply in P-46, the southern facing back room does not receive enough cooling air.
80	Repair relief air damper to prevent continued excessive losses of conditioned air from rooftop unit.
81	Repair malfunctioning flue damper.
120	Patch exterior siding on northeast side of building (behind kitchen area).
121	Outside air temperature sensor is exposed to sun. Place sensor back under its protective cover on AHU.
101	Sweep leaves out of mechanical yard next to kitchen. Leaves are piled up under propane filled water heater.
229	Several exit/emergency lights tested bad. Replace/repair battery packs.
210	Check alignment and tension of SA fan belts. They squeak when return air damper is not throttled down.
212	WAF vibrates under load. Remove restriction from return air flow, or add an in-line return fan. Fan in WAF will fail unless repairs are completed.
241	Return fan belts are broken. The fan is free-wheeling. Filters have 1.6" H_2O ΔP; consider cleaning.
295	Clean screens/filters at stairwell entrances of each wing. These are fresh air inlets to HVAC system.
295	Boiler lighting off and shutdown seems to produce some blow-by or popping. Check burner and controls for proper operation.
301	A/C unit #5 has no disconnect switch visible. Install one for safety. No filters were found installed on AHU.

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20 October 1992

MINUTES OF MEETING

AT: Fort Hunter-Liggett, California

ON: 1 October 1992 10:00 AM

SUBJECT: EEAP Limited Energy Study, Fort Hunter-Liggett, California
Kick-off meeting for Field Investigations
Contract Number: DACA05-92-C-0155 with the Sacramento Corps. of Engineers

ATTACHMENTS: (1) FY92 Energy Goals Worksheet (provided by Energy Conservation Office, Fort Ord)

THOSE PRESENT:

Name	Affiliation	Telephone No.
Richard F. Ducoing	Energy, DEH Fort Ord	(408) 242-2051
Mark Grindstaff	DEH, FHL	(408) 385-2514
Richard C. Lennig	Keller & Gannon	(415) 621-1199
Blair I. Horst*	Keller & Gannon	(415) 621-1199
Ronald J. Bush*	Keller & Gannon	(415) 621-1199

* Field Team Members

1. The meeting was held to kick off project field investigations at Fort Hunter-Liggett.

2. Mr. Lennig introduced the field team to attendees and summarized the scope of the data gathering task.

3. Mr. Ducoing stated that Mr. Tai H. Cao of DEH, MP, Ft. Ord will coordinate with K&G regarding preparation of DD Forms 1391 for recommended energy conservation projects.

4. Mr. Ducoing provided the attached FY92 Energy Goals Worksheet. He stated that $1.84 million is projected for FY92 electrical energy costs at Fort Hunter-Liggett. An application has been made to the Western Area Power Administration for an

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allocation of hydroelectric power. A portion of the electrical power needs will thus be met from a less expensive source. However, energy saving provects will be evaluated based on the present incremental (highest) cost of electric power.

5. Projects which are applicable to PG&E's rebate program should assume that the government can take advantage of rebates.

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